

**PROCEEDINGS:**  
**29<sup>th</sup> ANNUAL**  
**HAWAII PAPAYA INDUSTRY ASSOCIATION**  
**CONFERENCE**

**September 24–25, 1993**  
**Hilo, Hawaii**



**Proceedings:**  
**Hawaii Papaya Industry Association**  
**Twenty-ninth Annual Conference**

September 24–25, 1993  
Hilo Hawaiian Hotel  
Hilo, Hawaii

**PREFACE**

The Hawaii Papaya Industry Association held its Twenty-ninth Annual Conference on September 24–25, 1993, at the Hilo Hawaiian Hotel, Hilo.

Papaya ringspot virus (PRV), which was first identified in the main papaya-growing area of Puna on the Big Island in early May, 1992, continues to be of major concern for the industry. Several speakers addressed issues related to PRV: the rogueing program, cross protection, genetically-engineered resistance, and the possibility of patenting or licensing new cultivars.

Nineteen ninety-three was a year of change for the Papaya Administrative Committee. (In 1970 the Hawaii Papaya Industry Association petitioned the U.S. Department of Agriculture to operate the industry under the Federal Marketing Order program. The Marketing Order was issued effective May 15, 1971. Robert Souza, then Head of the Marketing Division, Hawaii Department of Agriculture, served as Acting Manager of the PAC as a result of an appropriation from the State Legislature to provide management assistance to the new group. On April 1, 1978, he left HDOA to become full-time manager of the PAC.) Robert Souza retired from the PAC on June 30, 1993, and Edith Lau serves as Acting Manager. Mr. Souza was honored at the conference as the HPIA Papaya Man of the Year for his long and dedicated service to Hawaii's papaya industry.

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Cover: In cross protection, a mild strain of papaya ringspot virus "protects" papaya plants from the severe form of the virus. Mild-strain cross-protected papaya seedlings are produced in the nursery by high-pressure spray inoculation. Photo courtesy of Dr. Stephen Ferreira.



# **HAWAII PAPAYA INDUSTRY ASSOCIATION**

## **29<sup>TH</sup> ANNUAL CONFERENCE**

Co-sponsored by the College of Tropical Agriculture and Human Resources  
University of Hawaii at Manoa

September 24 – 25, 1993

### **PROGRAM**

*Friday, 9/24/93*

- |                    |  |
|--------------------|--|
| 8:00 – 9:00 am     | Registration: Sarah Hauanio (Treasurer, HPIA) in charge  |
| 9:00 – 9:20 am     | <b>Welcome</b><br>Convenor: Delan Perry<br>Hon. Stephen Yamashiro (Mayor, Hawaii County)<br>Rodolfo Sibucan (President, HPIA)<br>Dr. N. P. Kefford (Dean, CTAHR) |
| 9:20 – 9:40 am     | <b>Status of the Papaya Ringspot Virus Control Program</b><br>Wayne Kobayashi (Hawaii Dept. of Agriculture)  |
| 9:40 – 10:00 am    | <b>Regulations Governing PRV Control</b><br>Myron Isherwood (Hawaii Dept. of Agriculture)  |
| 10:00 – 10:30 am   | Papaya Nectar Break<br>(Sponsors: Tropical Hawaiian Products, Brewer Environmental Industries,<br>and United AgriProducts)                                       |
| 10:30 – 10:50 am   | <b>Use of Cross Protection for Papaya Ringspot Virus</b><br>Dr. Ronald Mau (Dept. of Entomology, CTAHR)  |
| 10:50 – 11:10 am   | <b>Results of Field Trials for Genetically-Engineered Resistance to<br/>Papaya Ringspot Virus</b><br>Dr. Richard Manshardt (Dept. of Horticulture, CTAHR)        |
| 11:10 – 11:30 am   | <b>Patenting and Licensing Papaya Cultivars?</b><br>Bernard Corbe (Office of Technology Transfer & Econ. Development, UH)  |
| 11:30 – 11:50 am   | <b>Pesticides for Use on Papaya</b><br>Dr. Mike Kawate (Dept. of Environmental Biochemistry, CTAHR)  |
| 11:50 am – 1:10 pm | Lunch<br>Speaker: Bart Jones (Honokaa Farmers Cooperative)<br><b>Hamakua Coast: Agriculture in Transition</b>  |
| 1:10 – 1:30 pm     | <b>Papaya Losses During Marketing</b><br>Dr. Robert Paull (Dept. of Plant Molecular Physiology, CTAHR)   |
| 1:30 – 1:50 pm     | <b>Biocontrol of Fruit Pathogens</b><br>Kate Nishijima (USDA – ARS Hilo)   |
| 1:50 – 2:10 pm     | <b>Papaya Fungicide Research Update</b><br>Dr. Wayne Nishijima (Dept. of Plant Pathology, CTAHR)   |

- 2:10–2:30 pm **Ecology of *Bactrocera latifrons* Populations in Hawaii**  
Dr. Nic Liquido (USDA–ARS Hilo)
- 2:30–3:00 pm **Papaya Nectar Break**  
(Sponsors: Tropical Hawaiian Products, Brewer Environmental Industries,  
and United AgriProducts)
- 3:00–3:20 pm **Papaya Statistics**  
Homer Rowley (Hawaii Agric. Statistics Svc., Hawaii Dept. of Agriculture)
- 3:20–3:40 pm **Federal Marketing Orders: History and Purpose**  
Dr. John Halloran (Dept. of Agricultural & Resource Economics, CTAHR)
- 3:40–4:00 pm **Inspection Requirements for Papaya**  
Sam Camp (Hawaii Dept. of Agriculture)
- 4:15–5:00 pm **HPIA General Membership Meeting**

#### **EVENING PROGRAM**

AJA VETERANS HALL (361 Haihai Street)

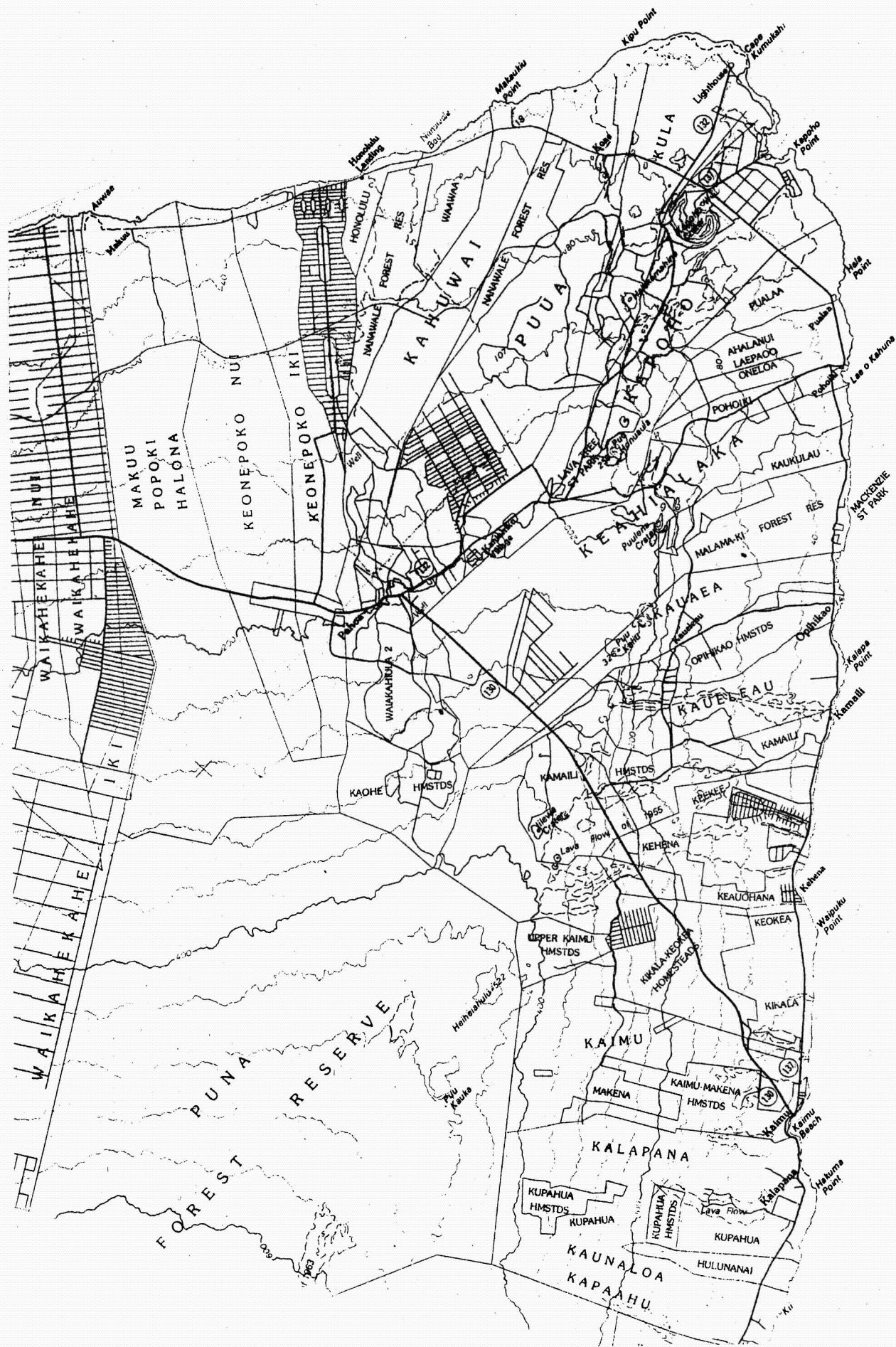
- 5:30 pm Aloha Session (Sponsor: Young Brothers, Ltd.)
- 6:30 pm Dinner  
Invocation: Sarah Hauanio  
Master of Ceremonies: Ahmad Yu (Hawaiian Host)

*Saturday, 9/25/93*

#### **FIELD TRIP SCHEDULE**

- 8:00 am Leave Hilo Hawaiian Hotel for Ka'u
- 9:00 am Tour Goats Unlimited (Host: Ann Peischel)
- 9:30 am Travel to Volcano
- 10:00 am Tour UHM-Volcano Experiment Station (Host: Richard Cupples, CTAHR)
- 10:30 am Travel
- 10:45 am Tour Volcano Winery & Vineyards (Host: Darrilyn Phelps)
- 11:30 am Travel to National Park
- 11:45 am Lunch at Bird Park
- 12:30 pm Leave for Hilo
- 1:15 pm Tour USDA–ARS National Clonal Germplasm Repository  
(Host: Dr. Francis Zee, Curator)
- 2:00 pm Drop-off at Airport
- 2:30 pm Pau at Hilo Hawaiian Hotel

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# Welcome Addresses

**Honorable Stephen Yamashiro**  
**Mayor, Hawaii County**

It is an honor and privilege for me to be here to welcome you this morning. Rusty Perry and I have known each other for a long time, and I have gained a lot of respect for him. Sometimes we do not always agree, but that is what conferences like this are about, to bring people together so you can share ideas, a very important facet of our Big Island industry.

We have all seen what has happened to the Big Island in the last few years. We have seen changes in our sugar industry with the phase-out of Hilo Coast Processing Co. in process and the pending closure of Hamakua Sugar, which will change the agriculture landscape tremendously. We will see a disappearance of the large industrial-scale agriculture that we have known and have been so comfortable with in the past. We have seen Puna change with Amfac going from grower-processor and shipper of papayas to some other form of operation. And this is a challenge for each and every one of you. I give all of you a lot of credit because sometimes I think anyone who is in agriculture, almost like being in politics, has got to be certified stupid or crazy, because there are so many problems and so many things that can go wrong. But on the other hand there are so many things that can go right and are rewarding when they do go right and you put it all together.

Providing food, I think, is one of the basic industries that we here on the Big Island are going to look forward to developing, that we can do here, that will be a big part of our changing economic environment for the years to come. But how that takes place, the form that takes place, will be the challenges that you have to decide: will it be growers individually, will it be cooperatives working together, will it be marketing organizations pursuing products? One of the things that I think the University has helped us with tremendously is that they have shown us that we can grow any number of products, we can grow a lot of different things. But one of the things I think that

they have not done is to show us what we can do with these products once they are grown, once they are harvested. The fresh market, which has been the staple of our industries, will I think prove very tenuous and very perilous in the future.

I was telling Rusty that I just came back from Tokyo. I like to walk through the stores and see what kind of products you can find. I was in some of the larger Japanese department stores in Ginza, and in their food areas I saw all kinds of fresh fruit. What they call papayas don't look anything like what we grow here; I wonder where they came from. You also see mangoes and many other fruits that are in competition with our papayas.

A year ago my wife and I were in Warren, Vermont, which is a resort community of about 4,000, and in the market there we found a tropical fruit display with papayas, pineapples, bananas, mangoes, starfruit, and other fruits that are in competition with papayas, and the problem was that the papayas looked the worst. They were black; they were mottled. Unless you knew what papaya was, and you wanted to eat papaya, there would not be the impulse to purchase. Everything cost about \$2.50 each; you had this one price and several choices.

These are the kind of things that I think we are going to have to face, and hopefully a conference like this can help you, the growers, shippers, and marketers, understand what we have to do to meet these challenges. We thank you for coming to Hilo. We hope that each and every one of you not only takes time to learn from these conferences, but also takes a trip around our island to see the many sights we have and meet the people, because I have often said that the people of this county and the things they have to share are the true beauty of our island. And they can help you tremendously. On behalf of all the people in the County of Hawaii, I welcome you and wish you a successful conference.

**Rodolfo Sibucan**  
**President, Hawaii Papaya Industry Association**

I welcome you to the annual HPIA Conference. I would like to take this opportunity to thank all the speakers for being here today to share their expertise on how we can solve all the problems that we are facing now.

And for us growers, I hope this conference will help you understand the problems that we are

facing, and we ask you to do what you can to help solve these problems, so that we can make a better future for our industry.

Lastly, my appreciation to our Mayor for being here, and to all the supporters of the industry. I hope that this will continue. Thank you.

# Update on the Papaya Ringspot Virus Situation in Puna

Wayne Kobayashi  
Plant Pest Control Branch  
Hawaii Department of Agriculture

I would like to start on a good note and tell you that PRV has been eradicated in Puna. Unfortunately this is not the case, but, nevertheless, we have made great progress in reducing the incidence of PRV in Puna. PRV was discovered a year ago, in May, affecting several thousands of papaya plants at the Pahoa orchards. Some felt that it was the kiss of death for the industry, in that the infestation had been present for six months or more, judging by the symptoms being expressed at that time. Although the number of diseased plants destroyed monthly has drastically declined, we are not out of the woods yet.

## Symptoms

Before I give an update of the Puna situation, let's review the symptoms of PRV. Although this has been done many times before, I'm sure there are some in the audience who are not familiar with the symptoms.

The most striking symptom of PRV is the chlorotic mottling of the leaves. Early symptoms, however, are difficult to detect, requiring a trained eye. Dark green streaking patterns also occur on the leaf petioles. The most damaging aspect of this disease, however, is what it does to the fruits. PRV results in low fruit quality, stunted, misshapen fruits, and ring patterns. Such fruits do not meet fresh fruit grading standards.

In terms of economics, the Big Island has over 2,000 acres in papaya production, or about 93 percent of the state's total papaya production acreage. The farm value of fresh papaya production on the Big Island is \$16.2 million, or 95 percent of the state's total of \$17 million.

The following quote by Dr. Stephen Ferreira, Extension Specialist in Plant Pathology, emphasizes the reality of how critical the PRV situation in Puna is: "In Hawaii, and elsewhere in the world, (PRV) has become a major production constraint whenever it occurs on papaya. Once introduced into an area, if drastic eradication measures are not implemented, it is only a matter of time before commercial production is no longer viable, generally in about five years."

## Chronology

To refresh your memories on the events of last year to present, let's go back and look at a chronology of events starting from May of 1992. May 5 is when the disease was discovered in Pahoa, after Loren Mochida of Tropical Hawaiian Products presented Wayne Shishido of the Hawaii Department of Agriculture (HDOA) with an infected plant sample. The following day almost 600 plants were tagged by our crew as being diseased. We then destroyed the diseased and suspect plants with consent from the farmers. It was on May 14 and 20 that meetings were held with the Papaya Administrative Committee (PAC), papaya industry people, the University, and the HDOA regarding the Pahoa situation. It was decided that the HDOA should pursue the enactment of a temporary 180-day emergency rule declaring PRV a pest for eradication, which would grant us certain powers provided by the statutes.

On June 18, the emergency rule was approved by the Board of Agriculture, and then approved by the Governor on June 25. With this rule, consent from the farmer and land owner was not necessary - we could go on to private property to implement eradication procedures after giving proper notification. A few weeks later, PRV was found in the Nanawale fields, and then in the Kahuwai fields. Once again at Kahuwai, the infestation was determined to be several months old, judging from the symptoms being expressed.

The emergency rule gave the department the authority to enter private property to take the steps necessary to eradicate PRV. However, those steps needed to be worked out with the growers and industry personnel. If you recall, the University's plan back in May 1992 to destroy all papaya plants in Pahoa was unacceptable. They also proposed that as much as a 60-foot radius rogueing procedure be implemented to eradicate in other areas. Actually, the University's proposal made a lot of sense, since there is no predictable pattern of the disease's spread, and that there are currently no reliable methods to determine if a plant has a latent infection.

At a meeting on July 29 between the department, UH, papaya industry, and a farmer

representative, a more conservative two-step rogueing procedure was developed, which I'll detail later.

The disease continued to be found in different areas in Puna: August 5 at Kapoho, November 23 at Geothermal, and December 15 at Opihikao.

Because the duration of the emergency rule could not exceed 180 days (expiring on December 21), the department initiated permanent rule making procedures, with the board granting approval to proceed with public hearings, which were held in April of this year, concluding with the Governor approving the permanent rules on August 25.

In the meantime there were more outbreaks of PRV in the Chow Ranch area.

The two-step rogueing procedure developed at the meeting on July 29 involved the removal of the diseased plant along with the four adjacent plants. Procedure A (Fig. 1) was implemented in an orchard for a period of three weeks. If the disease prevailed after three weeks, Procedure B (Fig. 2) was implemented until the disease was eradicated from the orchard. Procedure B involved the removal of all plants within a 30-foot radius of a diseased plant.

The result of the implementation of the eradication program is shown in Figure 3, a drastic

decline in the number of diseased plants taken down, from over a thousand in May to a low point in November and December. The current number of plants taken down monthly (50-100 plants) represents more than a 90 percent reduction from the original levels of last year.

As I mentioned before, the emergency rule was a temporary one. After it expired in December, most of the growers opted to not allow the continuation of the 30-foot rogueing radius, but only allow the X-pattern rogueing, or only allow the removal of diseased plants. However, we have been fortunate in that the disease has remained at a fairly low level in the months following the expiration of the rule.

The HDOA now has permanent rules in place and will be once again meeting with growers and papaya industry people to determine the course of action we will take. We hope to once again restore Puna's disease-free status.

Lastly, I would like to acknowledge six of the most hard-working people on our staff. They were instrumental in bringing an out-of-control disease situation to the levels that we see today: Wayne Shishido, Kyle Onuma, Paul Texeira, Randall Ioane, Steven Camara, and George Espaniola. They are here today to listen in on the meeting, but they will be back out in the fields next week.

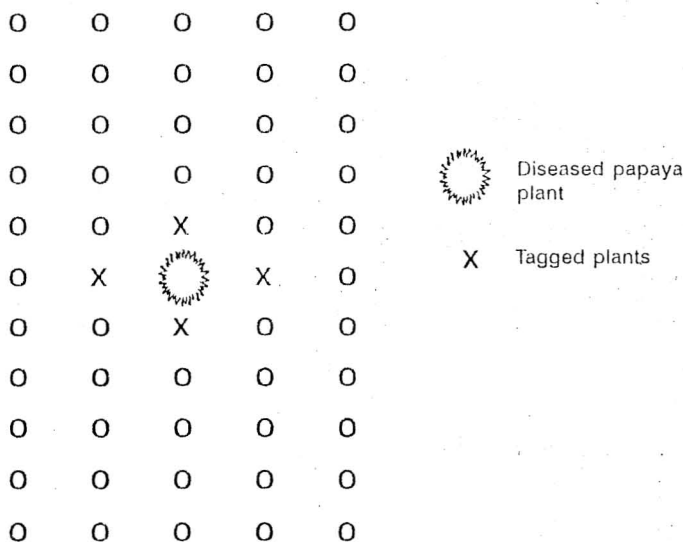


Figure 1. Procedure A.

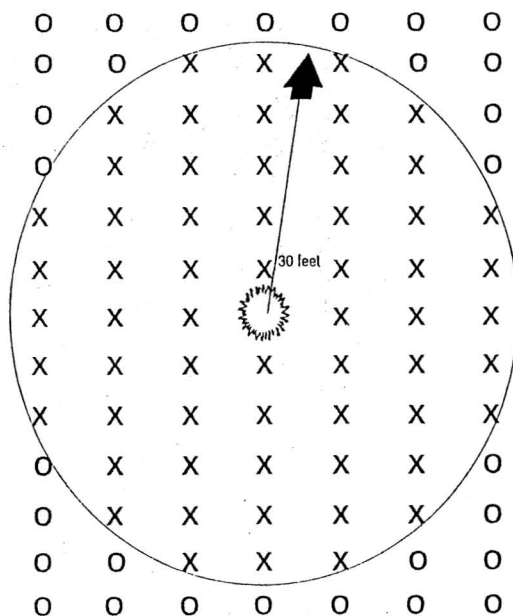
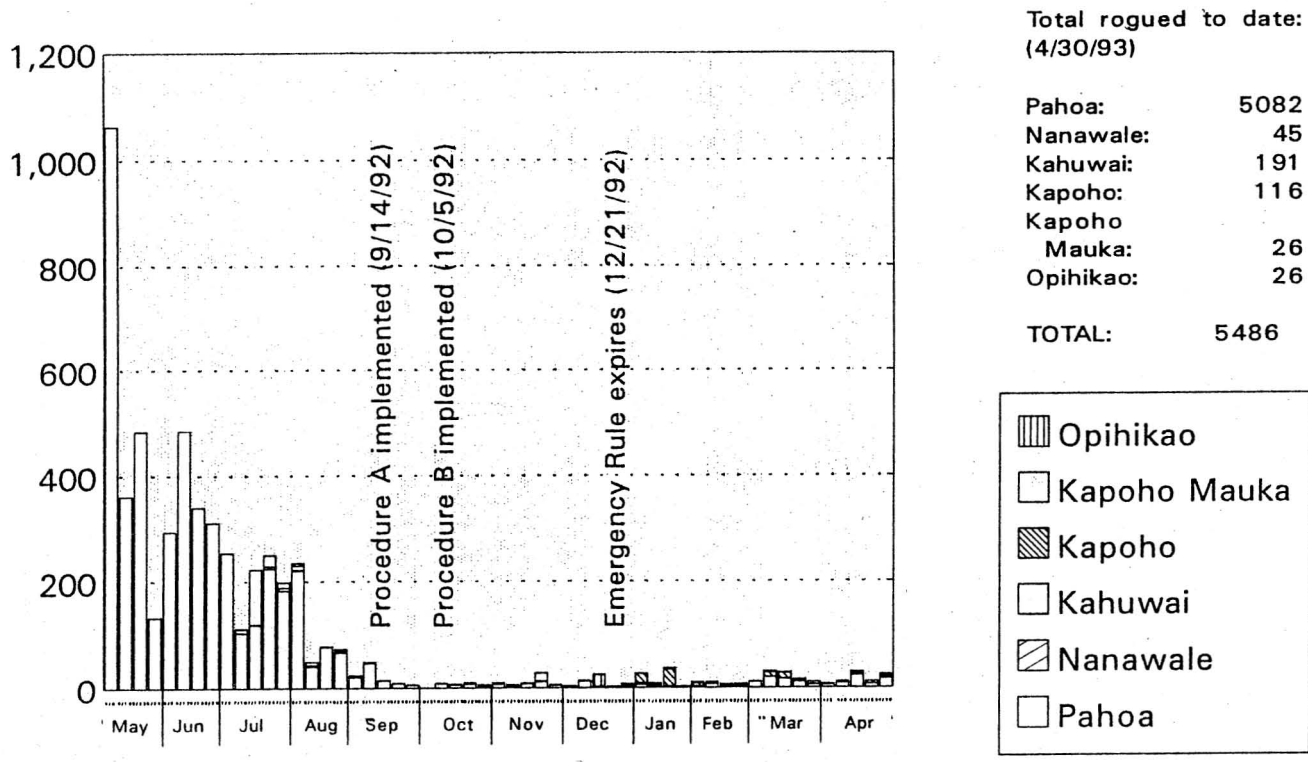


Figure 2. Procedure B.





**Figure 3. Number of PRV-infected plants rogued in Lower Puna, 5/92–4/93.**

# Regulations Governing Papaya Ringspot Virus Control

Myron O. Isherwood, Jr.  
Plant Pest Control Branch  
Hawaii Department of Agriculture

## Introduction

Several significant events affecting Hawaii's papaya industry and its battle with the papaya ringspot virus (PRV) have taken place since last year's HPIA conference. These events include the implementation of intensive roguing in lower Puna of papaya plants suspected to be or infected with PRV by the Hawaii Department of Agriculture (HDOA) under the 180-day emergency proclamation; the expiration of the emergency proclamation in mid-December, 1992; the HDOA's rule-making proposing and governor's approval in September, 1993 of Chapter 4-69A, Hawaii Administrative Rules (HAR), Pests for Control or Eradication, designating PRV a plant pest for control or eradication (see following appendix); the first distributions by the University of Hawaii's (UH) Plant Pathology Department of cross-protected papaya seedlings to growers on Oahu; and the Board of Agriculture's approval of the UH's proposal to conduct experiments near Panaewa to determine the effectiveness of cross-protecting the 'Kapoho' solo papaya variety against PRV.

## Current Regulations Affecting Papaya and PRV Controls

**Plant Quarantine.** Some of you may not be aware that the Plant Quarantine Branch of the HDOA plays a very important role in protecting agriculture from the entry into the state and/or the inter-island movement of agricultural pests within Hawaii by enforcing Chapter 150-A, Plant and Non-Domestic Animal Quarantine, Hawaii Revised Statutes (HRS). The provisions of the law are further expanded by administrative rules, and in the case of Chapter 150-A and papayas, Chapter 4-71, HAR, Non-Domestic Animal and Microorganism Import Rules, and Chapter 4-72, HAR, Plant Intrastate Rules.

PRV (Mild Strain) was listed on the Restricted List of Microorganisms (Part A), Chapter 4-71, HAR, which allowed for research by universities and government agencies. Listing of PRV (Mild Strain) in the Restricted List, Part A required the Board of Agriculture to establish and approve conditions for PRV (Mild Strain) for limited field

testing in the state. In response to a request from the University of Hawaii to field test the mild strain on the islands of Oahu and Hawaii, the Board established and approved conditions recommended by PQB staff at its meeting of January 20, 1993.

To allow commercial use of PRV (Mild Strain), the PQB initiated an amendment to its rules Chapter 4-71, HAR, to move PRV (Mild Strain) of the Restricted Microorganism List to Part B: For Private and Commercial Use. This amendment was approved by Governor Waihee and became effective on September 13, 1993. The amendment sets forth the Board's authority to establish more specific permit conditions relating to, but not limited to time, place, location, use, and special precautions. Under this revision, the Board is authorized to establish specific sites where PRV (Mild Strain) can or cannot be used. Another significant change provides for permit cancellation for violation of permit conditions.

The Plant Intrastate Rules require that all plant and propagative plant parts be inspected prior to being transported within the islands of the state. The transportation of papaya plants and plant parts except seed and fruit are prohibited from an infested area to a restricted area for PRV.

**Plant Pest Control.** Much of the authority for actions taken by the Plant Pest Control Branch (PPC) to control or eradicate plant pests are found in Chapter 141, HRS. This authority is expanded upon in Chapter 4-69A, HAR, which was approved by Governor Waihee and became effective on September 4, 1993.

What does this new authority provide to the HDOA in its efforts to control or eradicate PRV from your fields? It provides a number of options, depending on the intensity of infection, location, impact on affected farmers and the industry. Section 141-3, HRS, Designation of pests, control or eradication of pests, emergency power, states that "(a) The department of agriculture shall establish by rule, the criteria and procedures for the designation of pests for control or eradication. (b) The department of agriculture shall, so far as reasonably practicable, assist, free of cost to individuals, in the eradication of . . . diseases . . .

injurious to vegetation of value . . ." and "(c) Nothing withstanding subsection (a), if the department finds an incipient infestation of a pest that is injurious or deleterious or that is likely to become injurious or deleterious to the agricultural . . . industries of the State without immediate action, it may proceed without prior notice or upon a minimum of forty-eight hours notice and hearing adopt an emergency rule for the eradication of the pest to be effective for a period of not longer than one hundred eighty days without renewal."

Section 141-3.5, HRS, Control or eradication programs, states that "(a) The department of agriculture shall develop and implement a detailed control or eradication program for any pest designated in section 141-3, using the best available technology in a manner consistent with federal and state law. (b) For any pest designated by emergency rule as provided in section 141-3, the department shall implement an emergency program using the best available technology in a manner consistent with state and federal law."

Section 141-3.6, HRS, Entry of private property to control or eradicate any pests, reads "(a) The department of agriculture shall give at least five days notice to the landowner and the occupier of any private property of its intention to enter the property for the control or eradication of a pest. Written notice sent to the landowner's last known address by certified mail, postage prepaid, return receipt requested, shall be deemed sufficient notice. The notice shall set forth all pertinent information on the pest control program and the procedures and methods to be used for control or eradication. (b) After notice as required by subsection (a), any member of the department or any agent authorized by the department may enter at reasonable times any private property other than dwelling places to maintain a pest control or eradication program, being liable only for damage caused by acts beyond the scope of the person's authority, or the person's negligence, gross negligence, or intentional misconduct. If

entry is refused, the department member or agent may apply to the district court in the circuit in which the property is located for a warrant to enter on the premises to effectuate the purposes of this chapter. The district court may issue a warrant directing a police officer of the circuit to assist the department member or agent in gaining entry onto the premises during regular working hours or at other reasonable times."

Section 141-7 General penalty, Part (b) states "When any landowner or land occupier fails to cooperate with the department in its pest control or eradication programs, the department may proceed with its program at the expense of the landowner or land occupier. Any person who violates this chapter or any rule adopted by the department pursuant to section 141-3 shall be fined not less than \$100 nor more than \$500 for the first offense, and not less than \$1,000 not more than \$5,000 for each offense thereafter."

Chapter 4-69A, HAR, Pests for Control or Eradication, was approved by Governor Waihee following public hearings on all major islands. As required by Chapter 141-3.5 (a) HRS, PRV is designated in Chapter 4-69A as a pest for control or eradication. Testimonies received during the public hearings overwhelmingly supported designating PRV a pest and having the HDOA continue its intensive rogueing program in lower Puna.

As many of you recall, the 30-foot rogueing carried out under the emergency rule was a compromise reached after considering inputs from the university, industry, growers, and the HDOA. We plan to meet with grower association officers and packing house representatives in the near future to review the current PRV situation in lower Puna and to develop the next course of action, now that the rules Chapter 4-69A is in effect. We hope that the participants will come to an agreement on collective actions to be taken by industry, growers, and the HDOA, which will result in Hawaii continuing to have a strong, viable, papaya industry.

TITLE 4 DEPARTMENT OF AGRICULTURE  
SUBTITLE 6 DIVISION OF PLANT INDUSTRY  
CHAPTER 69A  
PESTS FOR CONTROL OR ERADICATION

- §4-69A-1 Scope of rules
- §4-69A-2 Definitions
- §4-69A-3 Criteria to designate pests for control or eradication
- §4-69A-4 Procedure for the designations of pests for control or eradication
- §4-69A-5 Control or eradication of noxious weeds; entry of private property

Historical Note: Prior rules relating to pest control were adopted under §141-2, Hawaii Revised Statutes, as chapter 69, Hawaii Administrative Rules, and were repealed on the effective date of this chapter. (Eff. 7/13/81, R SEP 04 1993 )

§4-69A-1 Scope of rules. These rules shall govern the criteria and procedures for designation of pests for control or eradication programs on public or private property other than dwellings in the State. (Eff. SEP 04 1993 ) (Auth: HRS §141-3) (Imp: HRS §141-3)

§4-69A-2 Definitions. As used in this chapter: "Agricultural industry" means agricultural, horticultural, aquacultural, or livestock industry.

"Board" means the board of agriculture.

"Head" means the head of the division of plant industry.

"Livestock" means farm animals kept for use or profit and includes but is not limited to horses, mules, cattle, sheep, goats, swine, and poultry.

"Noxious weeds" means those plant species determined to be or likely to become injurious, harmful, or deleterious to the agricultural industry, forest and recreational areas, and conservation districts of the State and which are designated and listed as noxious weeds in chapter 4-68.

"Other pests" means any invertebrate pest harmful to the agricultural industry or vegetation of value.



"Vegetation of value" means vegetation such as desirable trees, plants, and shrubs.

(Eff. ~~SEP 04 1993~~ ) (Auth: HRS §141-3) (Imp: HRS §141-3)

§4-69A-3 Criteria to designate pests for control or eradication. (a) Each insect, mite, other pest or plant disease designated by the department as a pest for control or eradication programs shall meet one or more of the following criteria:

- (1) There is a record of economic damage in the scientific literature documenting the designated pest's potential for injury to the agricultural industries or vegetation of value in the State.
- (2) The designated pest is causing or is about to cause economic loss by damage to a crop or agricultural commodity, by adversely affecting marketability, causing a loss in yield, or the like.
- (3) The designated pest transmits plant diseases which cause economic loss to a crop or agricultural commodity, by adversely affecting marketability, causing a loss in yield, or the like.
- (4) The designated pest is injurious or deleterious to livestock by virtue of being venomous, parasitic, or a carrier or reservoir of diseases.

(b) All noxious weeds designated pursuant to chapter 4-68 are pests for control or eradication within the meaning of this chapter.

(Eff. ~~SEP 04 1993~~ ) (Auth: HRS §141-3) (Imp: HRS §141-3)

§4-69A-4 Procedure for the designation of pests for control or eradication. (a) The head shall direct a continuous program of study and evaluation of insects, mites, other pests, or plant diseases for potential designation as pests.

(b) Study and evaluation of an insect, mite, other pest or plant disease for designation as a pest may be initiated by the head or, upon request, by other government agencies or private organizations.

(c) When sufficient data have been accumulated on an insect, mite, other pest, or plant disease to warrant designation, the head may submit to the board a request for designation as a pest for control or eradication.

(d) The insect, mite, other pest, or plant disease shall meet the criteria for designation as a pest, as provided in section 4-69A-3.

(e) An insect, mite, other pest, or plant disease shall be designated as a pest for control or eradication by the department following approval of the designation by the board, pursuant to chapter 91.

(f) The list of insects, mites, other pests, or plant diseases designated as pests, adopted by the board on May 27, 1993, and located at the end of this chapter, is made a part of this section.

(g) When the head determines that an insect, mite, other pest, or plant disease officially designated as a pest no longer meets the criteria for designation as a pest, the head may submit to the board a request to rescind the official designation for the pest. The request shall include a report with reasons to justify rescission of the designation.

(h) For rescission as submitted as outlined in subsection (g) above, the official designation of an insect, mite, other pest, or plant disease as a pest shall be rescinded following approval by the board, pursuant to chapter 91.

(Eff. SEP 04 1993 ) (Auth: HRS §141-3)  
(Imp: HRS §141-3)

§4-69A-5 Control or Eradication of noxious weeds; entry of private property. To the extent there may be any conflict between this chapter and chapter 4-68, control and eradication programs for noxious weeds shall be governed by section 152-6, Hawaii Revised Statutes, and chapter 4-68. However, if after following the procedures provided therein, entry to private property other than dwelling places for control or eradication of noxious weed infestations is refused, any member of the department or any agent authorized by the department may gain entry in the same manner as provided in section 141-3.6, Hawaii Revised Statutes, for maintenance of any pest control or eradication program."

(Eff. SEP 04 1993 ) (Auth: HRS §141-3) (Imp: HRS §141-3, §141-3.6, §152-6)

List of Insects, Mites, Other Pests, and Plant Diseases  
Designated as Pests  
for Control or Eradication Purposes by the  
Hawaii Department of Agriculture

May 27, 1993

INSECTS

<u>Scientific Name</u>	<u>Common Name</u>
<u>Adoretus sinicus</u>	Chinese rose beetle
<u>Aleurocanthus woglumi</u>	citrus blackfly
<u>Anastrepha</u> spp.	an exotic fruit fly species
<u>Anoplolepis longipes</u>	longlegged ant
<u>Aphis gossypii</u>	cotton/melon aphid
<u>Apis mellifera</u>	honey bee
<u>Aspidiella hartii</u>	turmeric scale
<u>Bactrocera correctus</u>	guava fruit fly
<u>Bactrocera cucurbitae</u>	melon fly
<u>Bactrocera dorsalis</u>	oriental fruit fly
<u>Bactrocera latifrons</u>	solanaceous fruit fly
<u>Bactrocera tryoni</u>	Queensland fruit fly
<u>Bemisia tabaci</u>	sweetpotato whitefly
<u>Ceratitis capitata</u>	Mediterranean fruit fly
<u>Cosmopolites sordidus</u>	banana root borer
<u>Coccus viridis</u>	green scale
<u>Cryptophlebia illepidia</u>	koa seedworm
<u>Cryptophlebia ombrodelta</u>	litchi fruit moth

May 27, 1993

§4-69A-4(f)

<u>Delia radicum</u>	cabbage maggot
<u>Diatraea saccharalis</u>	sugarcane borer
<u>Dysmicoccus alazon</u>	a mealybug
<u>Dysmicoccus brevipes</u>	pineapple mealybug
<u>Elasmopalpus lignosellus</u>	lesser cornstalk borer
<u>Frankliniella occidentalis</u>	western flower thrips
<u>Heteropsylla cubana</u>	leucaena psyllid
<u>Hypothenemus hampei</u>	coffee berry borer
<u>Hypothenemus obscurus</u>	tropical nut borer
<u>Keiferia lycopersicella</u>	tomato pinworm
<u>Liriomyza spp.</u>	agromyzid leafminers
<u>Metamasius callizona</u>	bromeliad weevil
<u>Monolepta australis</u>	redshouldered leaf beetle
<u>Myndus crudus</u>	American palm cixiid
<u>Myzus persicae</u>	green peach aphid
<u>Nezara viridula</u>	southern green stink bug
<u>Oryctes rhinoceros</u>	coconut rhinoceros beetle
<u>Ostrinia nubilalis</u>	European corn borer
<u>Pentalonia nigronervosa</u>	banana aphid
<u>Pheidole megacephala</u>	bigheaded ant
<u>Phoracantha semipunctata</u>	eucalyptus longhorned beetle
<u>Plutella xylostella</u>	diamondback moth



Pogonomyrmex spp.

harvester ants

Popillia japonica

Japanese beetle

Pseudonirvana rufofascia

two-spotted leafhopper

Sipha flava

yellow sugarcane aphid

Solenopsis invicta

red imported fire ant

Thrips palmi

melon thrips

Toxotrypana curvicauda

papaya fruit fly

Trialeurodes vaporariorum

greenhouse whitefly

Vespula pensylvanica

western yellowjacket

Xylosandrus compactus

black twig borer

## MITES

Acarapis woodi

honey bee tracheal mite

Polyphagotarsonemus latus

broad mite

Tetranychus cinnabarinus

carmine spider mite

Varroa jacobsoni

varroa mite

## OTHER PESTS

Scientific NameCommon NameCoenobita clypeatus

land hermit crab

Corbicula fluminea

freshwater clam

Dreissena polymorpha

zebra mussel

Helix aspersa

brown garden snail

Megalobulimus oblongusgiant South American  
snail

May 27, 1993

§4-69A-4(f)

Pomacea canaliculata

apple snail

Theba pisana

white garden snail

#### PLANT DISEASES

<u>Common Name</u>	<u>Causal Organism</u>
Bacterial wilt of heliconia	<u>Pseudomonas solanacearum</u> (banana, Strain D)
Banana bunchy top disease	Banana bunchy top virus
Black Sigatoka of banana	<u>Mycosphaerella fijiensis</u> var. <u>difformis</u>
Cadang cadang disease of coconuts	A viroid
Citrus canker or bacterial canker of citrus	<u>Xanthomonas campestris</u> p.v. <u>citri</u>
Coffee berry disease	<u>Colletotrichum coffeanum</u>
Coffee rust	<u>Hemileia vastatrix</u>
Downy mildew(s) of corn	<u>Peronosclerospora maydis</u>
	<u>Peronosclerospora philippinensis</u>
	<u>Peronosclerospora sacchari</u>
	<u>Peronosclerospora sorghi</u>
	<u>Sclerophthora macrospora</u>
	<u>Sclerophthora rayssiae</u> var. <u>zeae</u>
	<u>Sclerospora graminicola</u>

May 27, 1993

Fusarium wilt of banana (Panama disease)	<u>Fusarium oxysporum</u> f.sp. <u>cubense</u>
Koa disease	<u>Fusarium</u> <u>oxysporum</u> f.sp. <u>koae</u>
Lethal yellowing of coconuts	A mycoplasmalike organism
Maize chlorotic mottle disease	Maize chlorotic mottle virus
Moko disease of banana	<u>Pseudomonas</u> <u>solanacearum</u> Race 2 (banana, Strain B)
Orchid rust diseases	<u>Coleosporium bletiae</u> <u>Sphenospora kevorkianii</u> <u>Sphenospora mera</u> <u>Sphenospora saphena</u> <u>Uredo behnickiana</u> <u>Uredo nigropuncta</u>
Papaya ringspot virus	A virus

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69A-8

# Papaya Ringspot Virus Cross Protection – An Update

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Richard M. Manshardt<sup>3</sup>, and Dennis Gonsalves<sup>4</sup>

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## Background

Papaya ringspot virus (PRSV) is about the most serious disease problem growers must manage to successfully grow papayas in Hawaii. Growers on Oahu have long experienced the effects of this virus disease, the result of which has seen the decline of papaya production on Oahu to about 40 harvested acres in 1991 (Statistics of Hawaiian Agriculture, 1991). With the discovery of PRSV in the commercial growing areas in May 1992, growers face the serious possibility of losing their industry.

One of the few options available to growers is the use of cross protection. Cross protection is the "deliberate use of a mild or attenuated virus strain to protect against economic loss by the severe strain of the same virus." Cross protection is not a perfect or ideal disease management tool. We can expect reduced plant growth and yield as demonstrated and reported to you previously. For this reason, we think of cross protection as a last resort approach to PRSV management. However, the grower can expect certain benefits to using cross protection. By using cross protection, the grower obtains a lower, but more consistent and predictable yield for a known period of time. Thus, he avoids the wild swings in production often associated with crop failures due to high virus levels. Only by using the last-resort approach of cross protection is it at all possible to produce a crop economically.

In spite of its limitations, we believe that the use of cross protection affords growers a viable option for managing the virus disease. This is based on our previous studies which can be summarized as follows:

The mild protecting strain does not reduce fruit quality as measured by brix or sugar content for the important cultivars grown in Hawaii ('Line 8', 'X-77', 'Kamiya', and 'Sunrise'). Information on the variety 'Kapoho' is not available at this time since trials could not be conducted on the island of Hawaii.

Ringspots occur on fruit of all varieties. Ringspot occurrence varied by season, and tended

to be most intense during the late spring and early summer, with fruit set in the cooler winter months prone to expression of the virus.

Some cultivars should not be cross protected because they are too sensitive to the mild strain. In terms of the occurrence of ringspots on fruit, 'Line 8' was most resistant followed equally by 'X-77' and 'Kamiya', with 'Sunrise' the most sensitive. With 'Sunrise', fruit was also severely distorted for part of the year. This observation suggested that cultivars such as 'Sunrise' were too susceptible to be cross protected.

Growers produced acceptable yields of grade A quality.

Infection by the severe strain of PRSV (breakdown or superinfection) was substantially reduced by the use of cross protection. Rates of infection were reduced by over 90% even for the more susceptible cultivar, 'Sunrise'.

Cross protection technology is available now. Effective September 13, 1993, the governor approved the commercial use this technology on the island of Oahu. After testing on the island of Hawaii, similar approvals ought to be forthcoming.

## Commercialization of Cross Protection on Oahu

At the completion of our large-scale field trials/demonstrations of cross protection, a field day was held on Oahu in March, 1993, for growers to observe one of our trials. Results of the trials were presented, and discussion was initiated on how to commercialize or make cross protection available to growers. Over 50 growers attended the field day. Most growers seemed impressed with the consistency of production possible with this technology, and much discussion took place on how to proceed with commercialization of cross protection.

Growers decided that seedlings would be distributed equally to all interested growers who attended the field day. Mr. Ken Kamiya, an original cooperating grower for evaluating cross protection, was chosen to produce cross-protected seedlings for distribution at cost. The first two production runs of cross-protected seedlings would

be used to teach Mr. Kamiya how to produce cross-protected seedlings.

In mid-May 1993 about 37,000 seedlings were distributed to 16 growers from all of Oahu. Subsequently, additional growers who had not attended the field day expressed an interest in cross-protected seedlings. To accommodate these growers, additional cross-protected seedlings were produced and distributed. At this time, because we expected to experience a problem with producing cross-protected seedlings because of the warmer summer temperatures, only 21,000 seedlings were produced and only 15,000 seedlings were distributed to 11 growers.

In all, the number of seedlings distributed was adequate for planting 45-55 acres, or more than the 40 acres of papaya harvested for all of Oahu in 1991. Many growers expressed a desire for more seedlings, but initial distribution had to be limited to provide an opportunity for as many growers as possible to obtain experience with using cross protection. Growers receiving protected seedlings varied in previous experience with growing papayas from highly experienced to no previous experience. Their reactions and experiences with these seedlings will be monitored to determine the level of acceptance of cross protection by Oahu growers.

#### **Cross Protection on the Island of Hawaii.**

The cross protection program at the University of Hawaii was initiated about 10 years ago, anticipating a need for its deployment on the island of Hawaii whenever PRSV would become established in the commercial papaya-producing areas. Work proceeded only on Oahu because this was where PRSV was a problem. Since the cultivar 'Kapoho' is not grown commercially on Oahu, our experience with it is limited to greenhouse and small plots. In these tests, 'Kapoho' reacted intermediately compared to 'Line 8' and 'X-77'. Reactions must be confirmed in field-scale trials in soil and environmental conditions similar to the Puna area. We have received permission from the Hawaii Department of Agriculture to install the trial in Hilo.

In a few weeks, we shall install the experiment to evaluate cross protection on 'Kapoho' at Mr. Pang Van Lo's farm (located 0.3 miles west of the intersection of Kahaopea Rd. and Auwae Rd., on the right side of Auwae Rd.) in Hilo. We will assess the effect of the mild strain on fruit quality, the occurrence of ringspots on harvested fruit, visual plant reactions, yield, and superinfection, or "breakdown," by the severe strains of PRSV. Results will be shared with the industry as they become available.



# Update on Genetically Engineered PRV Resistance

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Genetic engineering for resistance to papaya ringspot virus (PRV) is another approach to controlling PRV in papaya. Unlike the cross-protection strategy, which Dr. Ron Mau indicated is now being implemented commercially, genetic engineering for PRV resistance is still in the research phase. Since I have discussed the procedures involved in creating genetically engineered plants at several previous HPIA meetings, I will only review these briefly here, before moving on to present the latest results from our field trial, mention the current plans for incorporating genetically engineered PRV resistance into commercial cultivars, and talk about some regulatory problems which have to be overcome before seed of genetically engineered plants can be distributed.

The genetically engineered papaya plants are resistant to PRV because they contain a foreign gene from the PRV virus itself that interferes with normal replication of the virus in the host papaya. The gene codes for the viral coat protein that surrounds the virus particle. The coat protein gene (CP) was isolated by Dr. Dennis Gonsalves, a virologist at Cornell University, and it was manipulated by Dr. Jerry Slightom of the Upjohn Company to permit the papaya to produce the PRV coat protein. Dr. Maureen Fitch, then a PhD student at UH and now with the USDA Sugarcane Technology Lab at the Hawaiian Sugar Planters' Association, put the CP gene into cells of specially prepared papaya tissue cultures and regenerated plants that produced the coat protein. One of the genetically engineered papaya plants has demonstrated a high level of resistance to PRV in greenhouse tests at Cornell and in Hawaii. Over the last year, a tissue cultured clone of this plant has been tested for PRV resistance in the field at Waimanalo, and it is the result of this test that I will present today.

The most promising resistance chanced to occur in a genetically engineered 'Sunset' plant with the identification code 55-1. This plant was cloned to produce 20 replicates, which were planted in the field along with 20 replicates of a 'Sunset' plant that was genetically engineered with genes other than the CP gene (the CP gene

control), and 20 normal 'Sunset' seedlings (the genetic engineering control). The objectives of the field trial were to (1) test the effectiveness of the CP gene as a PRV resistance factor and (2) determine whether the method of virus inoculation (manual versus natural aphid vectors) affected disease resistance or symptom severity. The experimental design was a split plot with 10 replicates, and the plants were manually inoculated in July 1992. Disease reactions in the inoculated plants were assessed on four occasions during the last year (November 1992, February 1993, April 1993, and September 1993), using a disease symptom rating scale (1 = no symptoms, 2 = mild, 3 = moderate, 4 = severe) and ELISA (enzyme linked immunosorbant assay) serological test.

The results of the field trial to date are very clear and as good as we could have hoped for. All control plants showed disease symptoms and high ELISA values within one month of the date of manual inoculation, or within four months if inoculation was left to aphids that are the natural vectors of PRV. In contrast, the 55-1 plants containing the CP gene have been completely free of PRV for 14 months, in spite of two manual inoculations and continuous exposure to local aphid populations (Table 1). Growth and vigor of the 55-1 plants, as measured by trunk diameter, was significantly better than in the controls (Table 2), and there did not appear to be any detrimental side effects of genetic engineering as far as reproductive fertility, fruit size, or sugar content were concerned. The method of inoculation had no effect on severity of symptoms or degree of resistance in any of the plants (Table 1). These initial results indicate a great success for genetically engineered PRV resistance, but the field test will be continued for a full two years to see if the protection persists.

Although several genetically engineered 'Kapoho' plants were produced and tested in this program, none of them proved to be as resistant to PRV as the 55-1 clone of 'Sunset'. The reason for this is not clear, but it probably has nothing to do with the cultivar differences between 'Kapoho' and

**Table 1. Effect of inoculation method (manual vs. aphid vector) and papaya genotype (transgenic CP+ [55-1], transgenic CP- control [62-1], and seedling CP- control) on PRV symptom expression.**

	Nov. 11, 1992	Feb. 9, 1993	Apr. 13, 1993	Sep. 8, 1993
Inoculate method	n.s.	n.s.	n.s.	n.s.
Papaya genotype	**	**	**	**
55-1 vs. controls	1.03 : 2.89**	1.03 : 2.36**	1.00 : 2.45**	1.00 : 2.79**
62-1 vs. seedling	2.90 : 2.88 n.s.	2.25 : 2.47*	2.40 : 2.49 n.s.	---

PRV rating scale: 1 = no symptoms, 2 = mild symptoms, 3 = moderate symptoms, 4 = severe symptoms  
n.s. = not significant; \* = significant ( $0.05 > P > 0.01$ ); \*\* = highly significant ( $P < 0.01$ )

**Table 2. Effect of PRV CP gene expression on susceptibility of papaya to PRV (measured by ELISA) and on trunk diameter.**

	ELISA range O.D. <sub>405</sub>	Trunk diameter (cm at 45-cm height)
Nov. 11, 1992		
Transgenic (CP+)	0.010-0.017	8.85
Control (CP-)	0.681-1.914	7.33 **
Feb. 9, 1993		
Transgenic (CP+)	0.020-0.084	12.14
Control (CP-)	0.868-1.891	9.55 **
Apr. 13, 1993		
Transgenic (CP+)	0.000-0.005	13.28
Control (CP-)	0.157-2.138	9.73 **
Sep. 8, 1993		
Transgenic (CP+)	0.000-0.014	14.49
Control (CP-)	0.387-0.993	8.87 **

\*\* = highly significant ( $P < 0.01$ )

'Sunset'. Most likely, the success of the product is dependent upon where in the set of nine papaya chromosomes the CP gene becomes inserted, with some regions being better than others for expression of the resistance factor. Since insertion appears to be random, it may simply be poor luck that we did not produce a more resistant 'Kapoho' on our first attempt. Dr. Gonsalves at Cornell has agreed to continue our collaboration in a new project, and we are again attempting to produce a PRV-resistant 'Kapoho'. In the meantime, the quickest way to use the resistance in 55-1 is to make conventional hybrids between it and other

commercially important cultivars, such as 'Kapoho' and 'Kamiya'. These hybrids will have yellow or orange flesh color and should be acceptable to growers and consumers. Preparations are being made to produce hybrid papaya seed incorporating the PRV resistance from 55-1.

The developments described above are mostly good news for papaya growers. The not-so-good news is that it may be awhile before genetically engineered papaya seed is available for commercial release. The U.S. Department of Agriculture considers genetic engineering, in which genes from one organism are moved into and expressed in another organism, to be a technology that has more potential dangers than conventional breeding. Consequently, the distribution of genetically engineered products is regulated by the USDA. The chief concern is that the competitive advantages conferred upon genetically engineered plants might allow them to persist in the agricultural environment and become serious weed problems. It now appears that, before seed can be commercially distributed, we must provide the USDA with data showing that the genetically engineered papaya is no more a weed threat than a normal papaya. It is not clear at this point what kind of data are required, but in the worst case, if several generations of seedling survival observations have to be accumulated in different environments, we are talking about years of work. There is some reason for optimism in that other crops will be passing over these deregulation hurdles before papaya, and they may set precedents that will permit speedier clearance in our case.

# Patenting and Licensing Papaya Cultivars ?

Bernard Corbe

Office of Technology Transfer and Economic Development  
University of Hawaii at Manoa

I am an intellectual property specialist at the at the University of Hawaii in the Office of Technology Transfer and Economic Development. This is a long name that basically means we attempt to commercialize and protect the new technologies and ideas that are coming out of the university. As an intellectual property specialist at OTTED, I work with inventors to patent their inventions.

Today I would like to speak to you about patenting, or the potential to patent, papayas. I think that at some point in time this could become an extremely important issue for all of you. What I would like to do today is introduce some of the basic concepts involved.

At some point in time you, as an industry, will have to come together and decide what to do about protecting new papaya varieties. You are going to have options whether to patent or not to patent. You may want to protect the developments created within Hawaii and keep them for Hawaii; or maybe you are going to decide to license them out to other countries. The anthurium growers right now are going through this exact type of decision-making process. It is a long, hard process for some of them, and learning from that experience is why I am here today. I am here to help to introduce you folks to the thought process and inform you so that you can slowly, in the back of your minds, prepare yourselves for the decisions that you are going to have to make some day.

Before I start into patenting I would like to do a little commercial for our office. I feel that perhaps we may be able to help some of you, and you may not know exactly who we are. OTTED's office is presently on Oahu. We have four basic offices; I am in the intellectual property section. Intellectual property is basically patents, trade marks, and copyrights. My job is to patent, trademark, or copyright the new ideas coming out of the university.

We also have three other programs. We have a seed capital program for people who are involved with the university who have good ideas. They can submit a proposal and get \$5,000, \$10,000, \$20,000; even up to \$250,000 has been awarded. If

any of you are connected with the university, this type of money is available to develop high-technology projects.

Another program that we have is an economic development and education program. This program primarily develops software within the university to help educate people outside the university. For example, we have a few programs in the works that are plant-oriented, botany-type software programs in which somebody is working on Hawaiian medicinal plants. There are very interesting ideas that we are working on in this program.

Last but not least, for those of you who are not involved directly with the university we have a technical assistance program. This program may be able to help some of you. The general public can come to our office if you need some sort of technical assistance or if you have a particular idea that you would like to develop. Our office will connect you with the appropriate professor or expert in their field within the university and they in turn will connect you with the person that can best help you with your needs. A lot of times, all you need to do is sit down with someone who is top in their field when you have a question or an idea. Sitting down with them for an hour or two can really make a big difference and be just what you need.

That is it for the commercial. Now we will get down to talking a little bit about patents and plants.

There are basically three types of protection for plants. The type of protection will depend upon the way that the plant was developed or created. The first type is the plant patent. Plant patents were originally introduced into the legislature in about 1930. The purpose was to grant plants the same type of protection that is offered every other type of invention. A second purpose was to give the developer of a new variety of plant the security to immediately come into the market at a low price because he knows he is going to be protected.

The plant patent protects new and distinct varieties of plants that can be reproduced asexually. This means that only asexual plants are



produced, without seeds. Any type of reproduction that is not using seeds is protected by the plant patent. With this patent you can restrict others from propagating new varieties through asexual means. This does not protect your seeds. It only protects the plant itself. There are about 8,000 plant patents since the 1930's. Primarily they are covering roses, because people want to protect their rose plants commercially.

In the papaya industry, I don't see the plant patent as the particular type of patent that you would want to use. It may be useful in some terms, but generally I think we are going to look to the plant variety protection certificate or the utility patent.

The second type of protection is the utility patent. This is used for your typical invention. Let me compare and contrast the difference between the plant patent and the utility patent. The utility patent is something that would be used more for Dr. Manshardt's type of discoveries, where the new papaya is a result of genetic engineering. The utility patent is not generally for biological materials. However, the biological materials that are being covered by the typical utility patent are genetically engineered biological materials.

If all this work being done on genetic engineering can now be patented by a utility patent, what does that mean? With a utility patent, you can restrict others from making, using, and selling the patented invention. More importantly, you can prevent someone from importing, using, or selling products of a patented process. Therefore, you have control to keep these products from coming in or going out of the country. Thus, you are starting to move into international control. If you have some genetically engineered papayas and you only want them in Hawaii, utility patents can prevent them from moving back and forth internationally. The patent could give quite a commercial edge.

The third type of protection is the plant variety protection certificate. This is possibly an appropriate form of protection that would be applicable to the papaya research that is going on at the university. This protects new varieties of sexually reproduced plants. The certificate was developed in the early 1970's by the U.S. legislature. The reason behind creation of the certificate was that seeds were not being protected. You could protect the plant, you could protect asexual reproduction, but people were moving seeds freely.

The plant variety protection certificate gives the ability to protect seeds, and requires certain

certifications on the seeds. This could be an applicable form because papayas are generally reproduced by seed.

What are the advantages of the plant variety protection certificate? You can restrict others from selling, offering, reproducing, importing and exporting, propagating or even hybridizing for the next the 18 years. Once again you have very good protection with the certificate.

Let's take a look at some of the requirements and the procedures involved in the patent process. For the plant patent, the variety must be distinct, novel, and unobvious. This is legal language that basically says it has to be a new plant invention. The procedure is that the U.S. Patent and Trademark Office reviews the invention and decides if it is distinct, novel and unobvious. This process takes about 2½ years.

As for the utility patent, which is used for the typical invention, the invention must also be new, useful and unobvious. In the papaya field this would apply to genetic engineering. Anything that is genetically engineered is fairly new and unobvious. Again, examination by the Patent and Trademark Office takes about two years. In the genetic engineering field you are lucky if you can find a patent examiner that can go through the process in two years. It will actually take about three years to get it through. The cost is about \$5,000 for one country. If you want to patent in Japan, that may be another \$5,000 to \$10,000 dollars. If you additionally want to patent in Holland or the Philippines, you are talking about another \$5,000 each country, so it can become quite expensive.

Finally, for the plant protection certificate the variety must be new, distinct, uniform, and stable. It cannot be changing, it must breed true. The examination is by the U.S. Department of Agriculture. The certificate is not a patent. The U.S. Department of Agriculture processes the certificate. That is nice because they are more efficient than the Patent and Trademark Office. The cost is considerably less - approximately \$2,000. Often it comes in under that cost.

The protections that you can get from these various forms of protection grant you certain rights. Once you have these rights you have the option to license. For those of you who do not understand the term "license," it basically means to sell with the reservation of certain rights. For example, if you had a plant variety protection certificate on the seeds of a certain papaya that is virus resistant, you could sell the seeds to someone

outright. If you sell the seeds outright to someone, they can sell the seeds to anyone else they want. However, once you have this type of protection you can license the seeds to someone and reserve the right that only they use these particular seeds. Or, you could reserve the right that they will not cross breed or interbreed. Or you can reserve any particular type of rights you want. That is the concept of licensing. It can be a powerful tool in protecting the industry in Hawaii. However, nothing is free. There is a cost benefit analysis that you as an industry as a whole will have to consider.

Let's look at the advantages of getting a patent or certificate. It will allow the Hawaii growers input into control over university developed cultivars. It is the policy of our office to follow the desires of the industry, whatever industry is involved. We have the option to do what the inventor wants, but for the good of the state we always go to the industry itself and ask for their opinion. We try to follow the industry's opinion regarding patents or other types of intellectual property protection. This is your way to give input into these decisions. Some people want patents, some people don't want patents because they find the process too cumbersome.

Another advantage of a patent or certificate is that it can give you the legal foundation to prevent propagation and sales by others. As I said, that is a very powerful tool. It gives Hawaii growers the potentially competitive advantage over other people who may not have these type of inventions.

A final advantage is that patents can create revenue through licensing, which can be returned to further research. For example, perhaps you want to charge a penny or two per packet of seeds based on a patent. That is called a royalty. You can decide that people in Hawaii get seeds royalty-free, while people outside of Hawaii pay 5 cents. The royalties charged are split: half goes to the inventor at the university, half goes back to our office to pay for the patenting or the plant certificate costs. A lot of the inventors put a major portion of their royalties back into research. If it came from papayas it goes back to papayas. It is pretty much a win-win situation for everyone with royalties.

However, let's look at some of the disadvantages. Nothing is free. The costs of a patent or a certificate can be substantial. As I said, you are looking at anywhere from \$2,000 to \$5,000 per country. You want to target your countries. Realistically speaking, the cost could be between \$5,000 and \$20,000 for the appropriate protection

that you might seek. Sometimes our office will pay the money up front, sometimes we'll seek at least a portion of the money from the industry itself. Every situation is different, but one way or another the costs will be paid eventually from the royalties. The royalties come from either your pocket or someone else's pocket who is buying the seeds or plant, so there is a cost involved.

Another disadvantage is that a patent or plant variety protection certificate can be difficult to enforce. If you go to Thailand and tell them, "Those are my seeds and you are growing my plant," they simply will say, "Call a cop." There are certain places where you are not going to be able to enforce your rights. On the other hand, there are many places that you will be able to enforce them, especially some of your larger markets. The way these things work is pretty much the way it works with books. Everyone knows that there is a copyright on books, but people copy portions of them anyway. However, you do not copy the whole book. The big players have a tendency to respect these type of intellectual property rights. Japan will respect these rights, Singapore will respect these rights. That is where your value lies.

Finally, the idea of cooperation could be an advantage or a disadvantage. It depends upon how you look at it. Cooperation is required among the industry to make these type of decisions. I know the anthurium growers are going through great turmoil trying to make a cohesive decision, but they will prevail to their advantage. I don't know in particular if it would be such a painful ordeal for the papaya growers. Such decisions require cooperation and cooperation requires time and energy.

That is about it, those are the issues that eventually you will face at some point in time. It may be next year, two years, or whenever, before something develops. Eventually we will come to you and ask the industry to start to think about these types of decisions. Hopefully this will warm you up. Are there any questions?

Q: Are there any varieties of papaya that have been patented?

A: None that I know of at this particular time. None through our office, anyway.

Q: Does the plant patent protect the seed or the papaya industry? Is it legal for someone to buy the seed that is protected by the plant patent and grow the seed and sell the product?



A: The plant patent does not protect the seed. The plant patent would protect from someone going out and doing tissue cultures or something like that, anything but the seed. Now in the case of genetic engineering, you would actually end up getting a plain old (utility) patent and that would

protect everything, seed, plant, you name it, because it is in the typical utility patent realm. The thing to remember between the plant patent and the plant variety protection certificate: the certificate protects the seed, the plant patent protects the plant.

FORM OF PROTECTION	PROTECTS	OWNER'S RIGHTS	REQUIREMENTS AND PROCEDURES
<b>1. PLANT PATENT</b>	Distinct and new varieties of plant that can be reproduced asexually.	Can restrict others from propagating the new variety through asexual means.	<ul style="list-style-type: none"> <li>• The variety must be distinct, novel and unobvious.</li> <li>• Examination by the U.S. Patent and Trademark Office (USPTO) takes about 2.5 years.</li> <li>• Cost About \$3,000</li> </ul>
<b>2. UTILITY PATENT</b>	Inventions and improvements (including biological materials and genetically engineered organisms).	Can restrict others from making, using, and selling a patented invention or importing, using, or selling the products of patented processes for 17 years.	<ul style="list-style-type: none"> <li>• The invention must be new, useful, and unobvious.</li> <li>• Examination by the USPTO takes about 2 years, on average.</li> <li>• Cost About \$5,000</li> </ul>
<b>3. PLANT VARIETY PROTECTION CERTIFICATE</b>	New varieties of sexually reproduced plants.	Can restrict others from selling, offering, reproducing, <b>importing, exporting,</b> propagating, or hybridizing the new variety for 18 years.	<ul style="list-style-type: none"> <li>• The variety must be new, distinct, uniform, and stable.</li> <li>• Examination by the U.S. Department of Agriculture (USDA) takes about 1-1/2 years, on average.</li> <li>• Cost about \$2,000</li> </ul>

**Table 1. Alternatives for plant variety protection.**

# Pesticides for Use in Papaya

Mike Kawate

Department of Environmental Biochemistry  
College of Tropical Agriculture and Human Resources  
University of Hawaii at Manoa

## Pesticides Registered for Papaya

The following tables list pesticides registered for use in papaya. If you have any questions regarding any of these or other pesticides, don't hesitate to contact me. New information primarily consists of new formulations of already registered products.

These lists should *not* substitute for the pesticide's label. The label is a legal document; therefore, before purchasing a pesticide, you should carefully read the label to determine if the product suits your needs and if it is legal for use in your crop (papaya). Not all products with the same active ingredient are registered for use in the same crops. If you have any additions or corrections to this list, please contact me (956-6008) as soon as possible.

## Status of Pesticide Projects in Papaya

### Reregistration

*Chlorothalonil (BRAVOR<sup>®</sup>)*. The field trial and residue analyses were completed. Final reports were submitted to IR-4 for review. Chlorothalonil residues exceeded the existing tolerance (15 ppm); therefore, an additional residue study is needed. When applying at the maximum use rate of 3 lb a.i. per acre, a minimum spray volume of 100 gallons per acre (preferably higher) should be used to avoid illegal residues, particularly if harvest occurs within a day of treatment.

*Malathion*. The field phase of the residue study was recently completed. The last shipment of samples were shipped to IR-4's Western Region Leader Laboratory, University of California at Davis, on 13 September 1993. An EC formulation was applied at 1.25 lb a.i. per acre in 100 gal of water. Some phytotoxicity on leaves was observed, though it did not appear to affect the fruits or tree growth.

### New Use Projects

*Permethrin (POUNCE<sup>®</sup>, AMBUSH<sup>®</sup>)*. This has been a difficult project because of the analytical methodology and report writing. Also, the

departure of the faculty member in charge of the residue laboratory, who has not yet been replaced, was a major factor in the cause of this project's delay. The POUNCE<sup>®</sup> label, although similar to the AMBUSH<sup>®</sup> label, did not specify a minimum gallonage per acre spray volume. Because we applied in less than 200 gallons per acre, we detected residues above the established tolerance (1 ppm). We will be advising IR-4 that FMC should modify their labeling to preclude the possibility of illegal residues. Furthermore, Hawaii's papaya growers, in general, would like to have a preharvest interval (PHI) shorter than 7 days (another limitation of the current label). Therefore, based on our findings, we will be able to propose an appropriate use pattern for papayas grown in Hawaii. A preliminary residue trial will begin in December 1993, and depending on the results, a GLP-compliant residue study could be initiated in mid-1994.

*Oryzalin (SURFLAN<sup>®</sup>)*. The tolerance was established in December 1992. DowElanco is looking into reinstating the use in papaya.

*Metalaxyl + copper (RIDOMIL<sup>®</sup> COPPER 70W)*. Communications between IR-4 and Ciba-Geigy have been established. Ciba-Geigy agreed to register this use if IR-4 conducts the residue study. We hope to initiate a residue study in 1994.

*Iprodione (ROVRAL<sup>®</sup>)*. Residue data that were submitted to IR-4 in 1991 appear sufficient to establish a tolerance. However, the acceptable daily intake (ADI) for iprodione has been exceeded; therefore, at the present time, no new uses will be allowed. IR-4 will keep us informed of any further actions.

**Note:** Mention of a trademark or proprietary product does not constitute a guarantee or warranty of the product by the University of Hawaii and does not imply its approval to the exclusion of other products that also may be suitable or that may inadvertently not have been listed. All materials should be used in accordance with label instructions.

### Insecticides and Fumigants Registered for Use in Papaya

<i>Common name</i>	<i>Trade name</i>	<i>Manufacturer</i>
<i>Bacillus thurengiensis</i>	DIPEL <sup>®</sup> 2X XENTARI <sup>®</sup> BIOBIT <sup>®</sup>	Abbott Abbott Du Pont
<i>Hexakis</i>	VENDEX <sup>®</sup> 50WP	Du Pont
<i>K-salts of fatty acids</i>	SAFER <sup>®</sup> INSECTICIDAL CONC.* ATTACK <sup>®</sup> SOAP CONCENTRATE	Safer Ringer
<i>Malathion</i>	PRENTOX <sup>®</sup> 5 LB MALATHION SPRAY HOPKINS MALATHION 57% E.L.-B	Prentiss HACO
<i>Metam-sodium (preplant)</i>	NEMASOL <sup>®</sup> SOIL FUMIGANT VAPAM <sup>®</sup>	Platte Zeneca
<i>Pyrethrins</i>	PYRENONE <sup>®</sup> CROP SPRAY PYRELLIN <sup>®</sup> E.C.	Fairfield CCT
<i>Sulfur</i>	WETTABLE SULFUR (HI-840008, expires 09/17/95) DREXEL SULFUR 90W (HI-920009, expires 09/17/97) THIOLUX <sup>®</sup> DF MICRONIZED SULFUR (HI-930007, expires 06/14/98)	FMC  Drexel  Sandoz

\* Product license not to be renewed according to HDOA's records.

### Herbicides Registered for Use in Papaya

<i>Common name</i>	<i>Trade name</i>	<i>Manufacturer</i>
<i>Diuron</i>	KARMEX <sup>®</sup> DF DIREX <sup>®</sup> 4L DIURON <sup>®</sup> 80 WDG DIURON <sup>®</sup> 80 WDG	Du Pont Griffin Platte Aceto
<i>Glyphosate</i>	ROUNDUP <sup>®</sup> MIRAGE <sup>®</sup> RATTLER <sup>®</sup> PROTOCOL <sup>®</sup> HONCHO <sup>®</sup> RULER <sup>®</sup>	Monsanto Platte Setre Monsanto Monsanto Wilbur-Ellis
<i>Oxyfluorfen</i>	GOAL <sup>®</sup> 1.6E	Rohm & Haas
<i>Paraquat</i>	GRAMOXONE <sup>®</sup> EXTRA	Zeneca

# Fungicides Registered for Use in Papaya

Common name	Trade name	Manufacturer
<i>Benomyl</i>	BENLATER <sup>®</sup> 50 DF (Supplemental label)	Du Pont
<i>Chlorothalonil</i>	BRAVOR <sup>®</sup> 500 BRAVOR <sup>®</sup> 720 BRAVOR <sup>®</sup> 90 DG TERRANIL <sup>®</sup> 6L TERRANIL <sup>®</sup> 90 DF ECHO <sup>®</sup> 720 ECHO <sup>®</sup> 90 DF	ISK Biotech ISK Biotech ISK Biotech Riverside/Terra Riverside/Terra Sostram Sostram
<i>Copper sulfate</i>	BASICOP <sup>®</sup> COPPER SULFATE CHAMP <sup>®</sup> FLOWABLE MICROFLO BLUE SHIELD <sup>®</sup> DF BLUE SHIELD <sup>®</sup> WP TRI-BASIC COPPER SULFATE (HI-790021, expires 06/21/94)	Griffin Agtrol Micro-Flo Micro-Flo Tennessee
<i>Mancozeb/Maneb</i>	DITHANER <sup>®</sup> F-45 DITHANER <sup>®</sup> M-45 DITHANER <sup>®</sup> DF MANZATER <sup>®</sup> 200 FL MANZATER <sup>®</sup> 200 WP MANZATER <sup>®</sup> 200 DF MANEX <sup>®</sup> II MANEX <sup>®</sup> II DF CLEAN CROP <sup>®</sup> MANCOZEB 4L CLEAN CROP <sup>®</sup> MANCOZEB 80 WP MANEB PLUS ZINC F4 PENNCOZEB <sup>®</sup> PENNCOZEB <sup>®</sup> DF MANEB 75DF MANEB 80	Rohm & Haas Rohm & Haas Rohm & Haas Du Pont Du Pont Du Pont Griffin Griffin Platte Platte Atochem Atochem Atochem Atochem Atochem
<i>Thiabendazole</i>	MERTECT <sup>®</sup> 340-F (HI-830009, expired 09/21/93)* DECCO SALT NO. 19	Merck  Atochem

\* Existing stocks should be used by 12/31/93.

# Hamakua Coast – Agriculture in Transition

Bart Jones  
Honokaa Farmers Cooperative

In 1975 I bought a macadamia nut orchard, and ever since I have been involved in diversified agriculture. Earlier this year a number of farmers and ranchers got together in Honokaa and formed the Honokaa Farmers Coop. The idea was to get the small farmers together and help diversified agriculture.

If you consider the recent changes in the area from Wailuku river to Waipio valley, it is obvious that East Hawaii is in a major transition. The year 2000 is about six years away, and the changes that are going to occur by that time in that 50 miles of Big Island coast are going to be as extreme as what happened a hundred years ago. We are in for a once-in-a-century change.

There is an old saying that beginnings are delicate times, and with the pace of our modern world, that statement is even more valid. It is very easy to kill a seed, and it is easy to destroy a seedling, and it is very difficult to establish and maintain all the elements necessary for the health, security, and the nurturing environment that is necessary to develop a new crop. We are thinking about this in East Hawaii; we are thinking of a brand new crop, whatever it may be. East Hawaii has all of the elements for a successful transition to a strong diversified agriculture. We have a good labor force that is experienced and hard working. We have management skills. We have soil, sun, and rainfall, and we feel we have markets that (I think you may agree) are just waiting to be opened up and developed. But before I make it sound too easy, let me acknowledge that this is a room full of farmers, and I know that *you* know that there is nothing easy about farming.

First a farmer has to look at the potential market. Then, hopefully, he or she can find some affordable land, open it up, pick the right variety, and diligently cultivate, herbicide, and fertilize. *If* there is no drought, *if* there is no flood, *if* there is no major wind storm or no new disease, the farmer can harvest the crop, take it to market, and hope that the market price has not changed and that the price will be enough to make a profit.

Fortunately our farmers have some allies, and we really need them now. Sugar had a hundred years to create the beneficial business climate that helped with taxes, zoning, infrastructure, and

markets. It had time to adjust to its needs and to its growth. Diversified agriculture has operated under somewhat similar conditions for the past fifty years. We have had homestead land and other marginal agricultural lands that slowly expanded, and the potential for diversified agriculture moved along with that expansion, and consequently our markets grew in a somewhat orderly manner. But now diversified agriculture has access to tens of thousands of acres of prime agriculture land, and we have little or no market. We have little or no in-field or social infrastructure designed for those crops, and we do not really have a business environment that is designed for diversified agriculture's benefit or, for example, for the papaya industry's benefit. Everything has been geared for sugar for 100 years.

This evolution from large corporate plantations to smaller diversified farms is a classic reflection of the change going on in America's business world. The stock declines and employee layoffs in giants like IBM exemplify old big business that is not able to move quickly within the international market place of the 1990s. But East Hawaii does not have much time to make all the changes necessary to fit into this new world. Our sugar workers have only months before the final harvest is over or their unemployment check ends. Our communities have only a short time to save and keep in the community those people that know every square inch of the area, know how to keep the equipment running, the machinery going. These are our assets that we are all working really hard to keep employed and in our communities.

I want to point out that we do have help from our local, state, and federal governments. First, thanks to our councilman Taka Domingo, we have under consideration a new agriculture park zone designation. This is a way that large land owners can develop their properties under ag-park zoning, and they do not have to build the infrastructure that usually must be built for urban developments. This is a way that land owners can develop and fit farmers' needs as opposed to urbanites' needs. Hopefully that will make it affordable, so that we can have affordable lands to move into and start farming.

The county has also been working on a new tax



code for agriculture. That effort has been going on for almost eight months, and the final report is at the county council. They are working on the final draft, and hopefully this will alleviate our tax burdens. It is designed for people that are serious about agriculture, as opposed to those who want to have a house and a horse on the property to get the ag zoning tax break. This is going to be a tax law that is designed for farmers.

On the state level, we have a lot of friends. Because I live in Hamakua, I have seen Representative Dwight Takamine work very hard to do many things for agriculture. This involves everything from legislation that strengthens the penalty for agriculture theft to a felony, to help in including East Hawaii in the Hawaii Community Development Authority's \$1 million system to cut through red tape and empower potential employers to do business in this area. Rep. Takamine, Senator Solomon, and other Big Island legislators pushed a number of helpful packages for Hamakua and North Hilo, including \$100,000 for the Hamakua Housing Corporation to plan the change in camp ownership, which is very necessary for a number of our people that live in the camps, and \$140,000 for a medical center to at least maintain the existing medical center while the new hospital comes in next year. Also, the Department of Land and Natural Resources is the expending agent for \$100,000 in 93-94 for a forest products initiative, and another \$100,000 in 94-95. I think it is valid to claim forest crops as a new diversified agriculture activity.

On the federal level we also have a lot of support. In particular, Senator Inouye has paid a lot of attention to our needs and tried to help out wherever he could. You can start with the \$600,000 that the Department of Labor is using to help retrain people who have been made unemployed or put out of business through the closure of the plantations. They are doing things like home health aid training, and training people to work on golf courses. There is also \$1.3 million for each of the next three years coming from HUD in response to the EPA saying that the two plantations need to fix up their settling ponds. So instead of imposing big fines that would get us in even deeper trouble, the federal government is saying that they will work with us to solve this problem. Because both plantations are suddenly going out of business and no longer need the settling ponds or the money to fix them, Senator Inouye was able to negotiate so that we can use this money in a positive way to help these

communities. That money is being designated for a number of things, including medical assistance for people that are no longer a part of medical plans, some housing issues, and a number of other projects.

There is also the million dollars from the Department of Defense for developing agricultural products in East Hawaii that could have applications for our military, and civilian populations as well. Some of the research projects that are under consideration include grass-finished beef, wetland taro grown on sugar land, medicinal products, and one project that is designed around your industry. Dennis Maeda has been involved in that project, a study to evaluate the feasibility of growing papaya on soils in East Hamakua, which has never been done commercially. Part of that proposal is developing and expanding markets, essentially targeting the military, and we hope to be able to bring in some civilian applications as well.

One thing about this Department of Defense funding is that although we are spending a lot of time going after markets, we and Dennis Tere-nishi, who is running the project, understand the importance of not putting farmers out of business once we learn how to grow a new crop somewhere else. First we go after the market, and we make sure that there is a way to expand it before we start putting more farmers on the land. One interesting thing about this DOD grant is that Senator Inouye, when he was here last month, said that he has appropriated another \$4 million that can be used for this kind of initiative if we spend the \$1 million wisely, so there is a lot of reason to do a good job with the existing money.

These are some of the governmental happenings. On the farm front, I called John Cross at Mauna Kea Agribusiness to make sure I was aware of what they are doing on their part of the coast. He said there is a lot of excitement and a lot of interest in agriculture. They have over 1,400 acres of their ex-sugar land licensed out to various farmers. Over 100 farmers are involved, with large to small farms diversified in everything from ginger and taro to pasture. They are also involved in the Department of Defense papaya grant and are going to be putting five acres in papaya so that we cover some distance, some here and some down the coast in Honokaa area. One of the most exciting things for them is their eucalyptus forestry products. They put that on a fast track, because everything looks positive. They have the results back on their medium-density fiber board, which



looks very promising, and consequently they are considering planting over 10,000 acres in eucalyptus forest.

Also on the Brewer properties is the 900-acre diversified agriculture park. It is very much in consideration, it is in development, and it involves the Chin Chuck, Ninole, and Wailea areas. The properties run mauka-makai, covering varieties of elevations and soils, and they hope to match that up with this new ag park county zoning. They are working on that and they feel they will have plenty of farmers to start filling it out.

Moving up the coast to Hamakua, I should first say that we are no longer the Honokaa Farmers Cooperative. The last meeting was Monday night, and we had tremendous interest. Many people came down from this side saying, "Hey, I work for Brewer but we are getting out of business too. What is the deal? Why Hamakua and why not us?" We said that it was not an exclusive organization; we had seen a need, and a bunch of farmers and ranchers had gotten together and said "Lets do it; this is the way to deal with that." Consequently, we changed the name to North Hilo/Hamakua Agriculture Cooperative. It is a lot longer and harder to say, but it includes the people that want to be included, and we are happy to have them. The initial motivation for this cooperative was the inability to acquire land, because most of parcels in Hamakua and North Hilo are 300-500 acres or more, which none of the small farmers could realistically afford, so we figured that we would cooperatively acquire the land and subdivide it, at least within our cooperative, in a way that would be beneficial to everyone.

Also, Mike Nagao, the Cooperative Extension Service administrator for the Big Island, immediately came to me and said he was pleased that this cooperative is here and that it was a good avenue for Extension to get information out to more farmers. So the coop is a way to acquire land and to help inform farmers. We have farmers

experienced in everything from dendrobium and anthuriums to mac nuts, taro, and papaya. It is a way that experienced farmers and new farmers can work hand in hand.

We will require some things. We have a committee whose job is to make sure that anyone who wants some land from the cooperative has to do a business plan and demonstrate an understanding of the market. We will do training to help people do this. We do not want to quash a market or get a farmer started where he is bound to fail. We are working hard to ensure that we create successful farmers. We have signed up in our survey over 1,500 acres that our members or potential members are interested in. There is a lot of interest in farming and a lot of interest in this land.

One of the things working with the cooperative has shown me is that we are all in this together. You may be a group of papaya farmers, but all of you know farmers that farm other things. All of you have been around other crops, and you drive by them every day. We are definitely all in this together.

Right now the livestock industry is having a hard time because new federal regulations are affecting the operation of the slaughter house; they are really concerned, and they have to worry. Well, I am involved with sustainable agriculture, and part of that is integrating livestock and farming operations. If we don't have a healthy livestock industry, that makes the whole situation more difficult. You papaya growers are having problems with ringspot virus. That is an issue on which you should be getting support from the whole agriculture community, because that needs to be addressed and solved. If we all work together, I think we can proudly ring in the year 2000 having shown the whole state how important diversified agriculture is to Hawaii now and for the future.

# Papaya Postharvest Losses During Marketing

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Postharvest losses generally are categorized into those that occur during storage, during transport, or at the wholesale, retail, or consumer level. Wholesale and retail losses are sometimes referred to as "shrink" (Kasmire 1975). Losses at the consumer level have been measured by holding samples under conditions that simulate those in home kitchens (Ceponis and Butterfield 1973), by analyzing the garbage thrown away by various segments of the population (Rathje et al. 1976), or by asking housewives to weigh all discarded food during a given test period (Rathje et al. 1976). In all of these procedures the amount of loss is determined, and in general no allowance is made for losses in quality aspects (Kader 1983).

Losses of papaya along the marketing chain can be ascribed to a number of specific causes. As with other fruit losses in handling chains, these loss causes are normally due to parasitic diseases, physiological disorders, mechanical damage, and overripe fruit (Ceponis and Butterfield 1981). In addition, quality losses can be a problem due to changes in appearance, texture, and flavor (Kader 1983).

The National Academy of Science in 1978 estimated postharvest losses of papaya as ranging from 40 to 100 percent. This figure was derived from a personal communication and probably only applies to the situation in a developing country. Pantastico et al. (1979) estimated for the Philippines that papaya postharvest loss ranged from 20 to 26 percent, with 8–12 percent of the loss being due to decay, 2–4 percent due to overripening, and 10 percent due to mechanical injury. A similar total loss figure of 21 percent was determined for Taiwan (Liu and Ma 1983). The loss in Taiwan occurred mainly at the retail level (14.3 percent), with 7.3 percent loss at wholesale and 2.1 percent during transportation. Though these figures were obtained in a different handling environment, they do indicate an upper level of possible loss.

In 1992, Hawaii shipped 37.5 million pounds of fresh papaya. Most of this went to the mainland U.S. and Japan. Before specific interventions to reduce losses can be introduced, it is necessary to determine what is causing the various losses. The

need for this information is heightened by the change to the forced hot air disinfestation treatment. In 1992, USDA inspected 59,638 cartons of Hawaii papaya and reported a range of defects (Table 1). Decay and mold were found in 73 percent of the inspected cartons, with 52 percent of the cartons having sunken defects. Total percentage higher than 100 percent indicates that more than one defect was found in one carton. Scarring and bruising were found on fruit in 72 percent of cartons; both indicate mechanical injury. It is unclear if overripe and soft fruit are the same conditions. These do not include losses that would occur at the retail level.

An additional object of the current program to estimate sources and extent of losses is to show wholesalers and retailers that Hawaii's shippers are interested in shipping high quality papayas. This perception could lead to better communication on loss problems and suggestions for changes. Also, shippers' concerns regarding the subsequent handling of this commodity would be made known to the wholesalers and, more particularly, retailers. At all steps, proper handling procedures could be reinforced and greater care taken in the handling of Hawaii papaya.

**Table 1. Postharvest defects of papaya shipped to the U.S. mainland, reported on USDA 1992 inspection reports.**

Defect	Percent
Decay	70.2
Mold	3.1
Sunken	51.5
Discoloration	11.8
Overripe	5.8
Soft	43.7
Scar	21.0
Bruising	51.4
Brown spot	5.2
Shrivelled	6.5

On March 31 and April 1 we interviewed and inspected papaya handling by the Los Angeles wholesalers. The wholesalers visited included Pacific Banana (Mr. Papaya), host: Adolph Robles; Vegland (Calavo), host: Jeffrey Long; Los Angeles Wholesale Markets; Umina Brothers (Calavo), host: Larry Hoy; Olympic Distributors (Mr. Papaya and Calavo), hosts: Adolph Robles and Manny Del Toro; Valley Produce (Calavo), host: Bill Flynn; and Blue Pacific (Ono Pac), host: Sam Nomura. Supermarkets were also visited.

The following problems were seen or voiced by distributors during the visit. These are not in order of significance, but grouped as to marketing, physiological, and pathological. Papaya fruit observed on the retail shelves were, almost without exception, of very poor quality. Fruit had chilling injury scald and were diseased, shriveled, and had many mechanical injuries. This damaged fruit was not being removed from the display as new fruit were put out for sale. We were embarrassed by the fruit condition.

All cartons of papaya shipped to California are repacked by the distributor or wholesaler to cull diseased and damaged fruit and to sort for color uniformity. Air-shipped fruit usually arrived in much better condition but good fruit quality was also seen in surface-shipped fruits. The fact that all distributors/wholesalers repack papayas shows that they do not have confidence in the quality of Hawaiian papayas shipped to the U.S. mainland. Apparently, papaya quality was so poor that retailers now insist on receiving papaya that have been repacked and will not accept sealed boxes. If fruit are received that have less than desired color (usually), the fruit are held to color them up prior to repacking and distribution to retailers. This "coloring" phase appears to be done with little thought as to optimum ripening temperature and time. Distributors use whatever space is available with little or no control of temperature. Some do better than others. The most problems observed were with distributors that held fruit for too long at temperatures that were often too low. This is a problem especially during the winter months and may have been a major factor responsible for the "outbreak" in January-February 1993. Papaya shippers are assessed a repacking fee for this service, and all culled fruit are deducted from the charges. Some distributors/wholesalers have created a "Number 2" grade where blemished but useable fruit are placed.

The current system needs to be improved to eliminate this time-consuming and costly practice

of repacking. Several options are possible. Fruit can be shipped in bulk bins sealed to meet quarantine requirements or in larger cardboard boxes. Fruit can be ripened in bulk bins to the proper color level prior to packing. Anthracnose and related diseases usually begin to appear on the ripe parts of the papaya by this time, and diseased fruit can be more readily culled. Papaya can be ripened by proper temperature maintenance enroute on the ship. However, fruit color must be uniform when packed. This procedure is made more difficult by changing wholesaler seasonal requirements, greener fruit in summer when ripening can be done on the mainland, and riper fruit in winter when low temperatures make it more difficult to ripen on the mainland. Improve quality of fruit so confidence increases, and repacking is not necessary. This would require developing techniques to assure ripening of all fruits in one carton as a cohort.

Cartons collapse due partly to incorrect stacking on pallets, rough handling, and loss of structural integrity due to damp boxes. Almost every pallet had one or more collapsed boxes. Cartons loaded in LD3 containers also had crushed boxes as a result of forcing boxes into uneven spaces. Collapsed boxes usually resulted in all or most fruit being squashed and unsalable. Boxes should be properly stacked - boxes should be stacked in the same pattern on the pallet six high before cross stacking is done. This technique makes use of the structural strength of the boxes.

Some wholesalers are keeping fruit 1½ weeks or longer before they even open the cartons to repack; others move the fruit out within two days. Much of the decay and quality problems appear to be related to the length of time the wholesaler holds onto the fruit. The usual reason given by the wholesaler as to why fruit are held so long is because the fruit are too green, and they need to ripen them before selling. In general, fruit disease becomes a serious problem after three weeks storage at 50°F, due to the physiological stress suffered during this storage period. The primary reason for holding on to fruit for extended periods is to "color-up" the fruit; a system needs to be developed and followed to "ripen" fruit under the proper conditions before shipping or after receiving on the West Coast. Storage/ripening space is a problem locally but a lot of the subsequent problems could be eliminated if this ripening were done properly.

The consumers, according to the wholesalers, prefer smaller fruit. Hence, the market prefers

smaller fruit (#8 and smaller). Number 7 fruit had a lot of bruising (squashing) because of the non-symmetrical packing scheme with seven fruit in a rectangular box. This is also true of fruit such as avocado and mango, partly due to the cost-per-fruit factor. Restaurants may not object to the larger fruit, as fruit will be sliced or cubed before serving. The local market probably will also accept the larger fruit. Consumer preferences as to acceptable fruit sizes need to be determined. The industry needs to reevaluate fruit size as a marketing tool. Perhaps smaller fruit can be targeted for home use and larger fruit for institutional use. Most of the papaya seen on the retail shelves were beyond their prime. Unless displays are improved, the Hawaii papaya will have a difficult time maintaining its position in the market.

### Physiological

All distributors mentioned the "soft fruit" problems that caused serious quality problems last October. The "soft fruit" can be divided into two types; some distributors referred to bruised or squashed fruit as "soft" fruit. The "soft" fruit problem that occurred last October and November is a physiological problem associated with low fruit calcium. Part of the confusion is due to the fact that this low-calcium fruit is much more susceptible to mechanical injury when compared to fruit with the same degree of fruit coloring and adequate calcium. The low-calcium "soft" fruit problem is sporadic but appears to be most common in the fall. It is not known when during fruit development the critical period is for calcium uptake. Foliar application of calcium is ineffective; thus soil applications are necessary.

Numerous mechanical injuries were observed on fruit at the distributors and at the retailers. It was not unusual to find mechanical injury on all fruit in a carton. Fruit at some retailers are displayed in wicker baskets, and all the riper fruit had indentations caused by the wicker.

Papaya at all ripeness levels are susceptible to scratches and punctures when in contact with rough or sharp surfaces. These wounds can then serve as infection sites for numerous wound pathogens that result in much of the postharvest diseases. These wounds, even without infection by pathogens, are unsightly and cause moisture loss and excessive shriveling. Fruit with 60 percent or more color are also very susceptible to internal bruising. Bruising is caused by rough handling of fruit during harvesting, heat treating, packing, and

shipping. Bruising results in localized soft parts of the fruit and a water-soaked region in the flesh when cut open.

Careful handling is essential from the time it is harvested to the time it is sold. Liners for wooden bins should be evaluated for cost and efficiency in reducing abrasive mechanical injury, as well as using bins made out of materials less prone to have rough surfaces. The latter may have a higher initial cost but might last longer. Handling at the packing shed during treatment, packing, and shipping must be evaluated to identify points at which injury may occur to the fruit (sharp edges, rough surfaces, high drops, etc.). Different packing materials should also be evaluated. One shipper recently converted to shredded newspapers and the distributor/wholesaler thought it made a big difference in bruising damage.

A few fruit with heat damage were observed. It appeared as a mild surface scald and failure to ripen (soften). The reason for having heat damage, however slight, is uncertain. We do know that there is a seasonal (temperature) effect on susceptibility to heat damage. Post-treatment storage at lower than recommended temperatures before the fruit ripeness may also compound the effect.

Chilling injury was seen on ripe fruit at the retailer. The injury is related to the length of storage at temperatures less than 50°F. Retailers and distributors need to be educated to refrain from long-term storage (three weeks) at temperatures below 50°F.

### Pathological

The most common disease problems observed were those caused by the fungus *Colletotrichum gloeosporioides*: anthracnose, chocolate spot, and grey-depressed lesion. These diseases are initiated on developing fruit in the field, but symptoms do not appear until the fruit ripens. Field sprays are required to prevent fruit infection. Postharvest heat and fungicide treatments can reduce but rarely eliminate these infections. Rainy weather favors the development and spread of the disease. A single hot-water dip done after the vapor heat treatment has been shown to slightly reduce postharvest disease and might be an additional step that shippers could use during periods of heavy disease pressure (rainy periods).

Postharvest diseases caused by wound pathogens were also a problem. *Phomopsis* and *Rhizopus* were two other diseases that were commonly seen on fruit in LA. These two fungi



are wound pathogens and take advantage of open wounds to gain entry into the fruit. They are both fast growers and cause a soft rot leaving the cuticle intact. The latter causes the infected area to become soft and watery, often causing the boxes to become soggy and weak. All precautions to minimize wounds should be made. Ripening to about 1/3 color prior to packing would bring out most of these diseases and allow culling. Proper use of chlorinated water in dumps, packing house sanitation, and postharvest fungicides should also reduce disease incidence.

One shipment of fruits packed on March 1, 1993, was being repacked in Los Angeles on March 31 by the distributor/wholesaler. These fruit need to last at least another week to pass through the retailers' hands to the consumer. Fruit was received about 1½ weeks earlier, ripened (?), and stored at 45–48°F until the day of repacking. Fruit were infected with numerous chocolate spots, anthracnose, *Phomopsis*, *Rhizopus*, and *Guignardia*. Some fruit showed some minor heat-scald damage. A recurring pattern that became obvious was that the longer fruits were held, the more disease was present. This agrees with all storage studies done in Hawaii. Fruit received a day or two prior (both surface- and air-shipped) were generally in good condition with little disease. Distributors are holding on to fruit

primarily to ripen fruit to a color that is acceptable to their buyers. As discussed earlier, refrigeration at temperatures below 50°F for extended times (three weeks) puts additional stress on the fruit and will intensify disease problems.

### Conclusions

There are a few simple steps that can be taken to reduce the problems seen at the LA wholesalers. All individuals involved in handling papaya need to recognize that their actions can significantly influence the fruit condition. These steps include avoiding mechanical injury, sanitation, more attention to the range of fruit color stages in one carton, and more care in stuffing LD3s. Long-term steps include incorporation of calcium in grower fertilizer practices, evaluating alternative physiological and economic aspects of different ripening and handling practices, and educating wholesalers and retailers as to proper handling procedures. A component of the long-term education would be to develop a comprehensive brochure or handbook giving symptoms of disorders and diseases and correct handling procedures.

We will be expanding the current project to include an evaluation of the next step in the marketing chain: retailing.

# Biological Control of Postharvest Fruit Pathogens in Papaya

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First of all, since the area of biological control is so vast, I will be restricting my talk to the area of biocontrol of postharvest fruit pathogens.

Fungicides are a primary means of controlling postharvest diseases. However, as a result of public concern about the presence of synthetic chemicals in our food supply and environment, several fungicides have been banned by the U. S. Environmental Protection Agency, or have been voluntarily withdrawn from the market for postharvest use (Wisniewski and Wilson 1992). The papaya industry has also experienced the temporary loss of registration of the use of Dithane fungicide. We now face an urgent need to develop new and effective methods of controlling postharvest diseases, not only for papaya, but for other commodities as well.

Sanitation and exclusion can help reduce inoculum level of pathogens, the use of non-selective chemicals (sodium carbonate, sodium bicarbonate, active chlorine, and sorbic acid), and heat treatments can lower the disease pressure on harvested commodity. Minimizing injury to the commodity during harvesting and postharvest handling, and maintaining the commodity at storage conditions that optimize host resistance, will also aid in suppressing disease development after harvest (Wisniewski and Wilson 1992). And, recently, attention has been focused on biological control of postharvest diseases as an alternative to the use of fungicides.

What is biological control? Biological control of plant disease is defined as "the decrease of inoculum or the disease-producing activity of a pathogen accomplished through one or more organisms, including the host plant, but excluding man." (Kenneth F. Baker 1987)

The area of biological control of postharvest diseases has been revolutionized by Pusey and Wilson (1984), and Wilson and Pusey's studies (1985) on the biological agent, *Bacillus subtilis*, a bacterium which was applied directly to peaches after harvest to control brown rot, *Monilinia fructicola*. Since then, there have been numerous reports of other microorganisms that control postharvest diseases of various commodities (Table 1).

Commodities that have been reported to use biocontrol agents include: apple, apricot, citrus, cherry, grape, nectarine, peach, pear, pineapple, plum, and strawberry. The microorganisms used include bacteria, yeasts, and fungi. Some of the organisms will be elaborated on later.

What are some of the characteristics of an "ideal" postharvest biocontrol agent?

The ideal postharvest biocontrol agent is (1) genetically stable, (2) effective at low concentrations (3) not fastidious in its nutritional requirements (not be too "restrictive," or requiring of "exotic" ingredients), (4) amenable to production on inexpensive growth medium with a long shelf life, (5) easy to dispense (6) able to survive adverse environmental conditions (that is, compatible to commercial handling and storage practices, including low-temperature and controlled-atmosphere storage), (7) effective against a wide range of pathogens on a variety of commodities (to make it "cost effective" and increase its market value) (8) safe to human health, and (9) nonpathogenic to the host (Wisniewski and Wilson 1992).

How does the biocontrol agent work? What are possible modes of action?

Except for the production of antibiotic zones by the biocontrol agent in petri dishes when challenged with the pathogen, the mode of action of many of the biocontrol agents is poorly understood. When antibiotic production is not a factor, the mode of action probably involves a complex syndrome of characters, including nutrient competition, site exclusion, attachment of the antagonist (biocontrol agent) to the pathogen, induced resistance in the host, and direct parasitism of the pathogen (Wisniewski and Wilson 1992).

Biological control of postharvest diseases of fruits and suggested modes of action are detailed in Table 2. Under antibiotic production, except for the fungus *Trichoderma* sp., all of the antagonists are bacteria. Under nutrient competition and or induced resistance, *Pseudomonas syringae* which controls blue mold of apple, and *Enterobacter cloacae* which controls rhizopus rot of peach, are bacteria. *Acremonium breve* is a fungus, and *Pichia*



*guilliermondii* is a yeast. Note the yeast, *Pichia guilliermondii*, because I will be detailing some of the work that's being done on this biocontrol agent.

As research on biological control of post-harvest disease continues, our knowledge on how the antagonists work will increase, and this knowledge should help us to develop more reliable procedures for effective application of known biocontrol agents and efficient selection of other antagonists.

As mentioned earlier, the work of Drs. Wilson and Pusey (1984, 1985) had a significant impact on the field of biological control because they applied a biological agent to control a postharvest disease. The mode of action of the bacterium, *Bacillus subtilis*, isolate B-3, is the production of an antibiotic which inhibits the pathogen, *Monilinia fructicola*, which causes brown rot of peaches and other stone fruits. In an agar culture, the bacterium produces an antibiotic which results in an inhibition zone which appears as an area of clearing among mycelia of the fungus. In their studies, *B. subtilis* isolate B-3 was applied to wounded peaches, nectarines and apricots and compared with benomyl fungicide and water. B-3 was as effective as benomyl in controlling the brown rot pathogen.

How does all of this relate to the Papaya Industry?

Except for studies on the control of phytophthora root rot of papaya by microorganisms in soil by Dr. Wen Ko in 1971 and 1982, the area of biological control of pathogens of papaya has been ignored. Our laboratory became involved in the area of biological control of pathogens of papaya about 5 years ago. More specifically, we worked on biological control of *Phytophthora* fruit rot of papaya.

Papaya fruits and leaves were washed in distilled water, then the filtered "washes" were plated out on agar which were "seeded" with spores of *Phytophthora palmivora* or *Colletotrichum gloeosporioides*. "Clear" areas in the mycelial area indicated that microorganisms in the "washes" were inhibiting fungal growth. Plates "seeded" with *Colletotrichum gloeosporioides*, showed the inhibition effects from the washes more clearly than plates seeded with *Phytophthora palmivora*.

We isolated an unidentified bacterium, designated as Wa-60, which produces an antibiotic compound in media. Wa-60 was streaked on agar medium, incubated for 2-3 days, then challenged

with spores of *Phytophthora palmivora* or *Colletotrichum gloeosporioides*. Zones of inhibition were pronounced on potato dextrose agar challenged with spores of *Colletotrichum gloeosporioides*.

Wa-60 also inhibited germination of *Phytophthora palmivora* zoospores in in vitro tests, and symptom development on papaya fruit. Inoculation tests on papaya fruits were conducted in which assay discs were dipped in cell-free broth extracts of Wa-60, placed on papaya fruit, then challenged (inoculated) with zoospores of *P. palmivora*. Fruits were held in humidity chambers consisting of plastic vinyl bins containing a layer of water on the bottom of the bins. The result of the inoculation tests on papaya fruit was the absence of phytophthora symptoms where discs were treated with cell-free extracts of Wa-60, compared to phytophthora symptoms on areas with water control discs.

How can biological control agents be used commercially?

Attempts are being made to commercialize some of the biocontrol agents. As part of this process, patents have been issued or are pending on some of these microorganisms (Table 3). The bacterial biocontrol agent, *Bacillus subtilis*, which has a patent, was incorporated into a fruit wax and was treated on peaches on a commercial packing line (Pusey et al. 1986, 1988).

The yeast biocontrol agent, *Pichia guilliermondii*, which controls gray mold of apple and green mold of citrus, also has commercial potential. McLaughlin et al. (1990) demonstrated that the addition of 2% calcium chloride to the yeast suspension, increased the ability of the yeast to control gray mold on apple. Hofstein et al. (1991) showed that the biocontrol activity of *Pichia guilliermondii* was enhanced with the addition of 10% of the normal rate of thiabendazole fungicide. In addition, a USDA-ARS researcher, Dr. Raymond McGuire, found that adding this yeast to fruit coatings inhibited green mold of grapefruit, and extended the shelf life of grapefruit for up to two months (Stanley 1993). At a commercial packing house, grapefruit were washed and inspected for defects, then the wax and yeast mixture was sprayed on the fruit surface. Fruit not treated with the yeast became decayed with *Penicillium* mold, while fruit coated with the wax and yeast remained healthy. Of special note: the yeast was originally discovered on lemons and has been patented by Dr. Charles Wilson. The fruit coating used in Dr. McGuire's research is called Nature Seal, which is an "edible" coating

that is produced commercially.

These reports suggest that biocontrol procedures can be integrated into commercial postharvest operations.

With all of these antagonists reported to control postharvest pathogens, what's preventing their successful commercialization?

Three primary barriers have been (1) the relative ineffectiveness of antagonists (biocontrol agents) compared to chemical control procedures; (2) the procedural processes for governmental clearances that have yet to be streamlined; and (3) a lack of economic incentives. With regard to the latter, a huge investment of time and money is required to establish whether an antagonist has commercial potential.

There are also challenges in the development of fruit biocontrol agents: (1) limitations of the biocontrol agents, (2) adaptability to commercial processing and storage practices, (3) determining effect of a biocontrol agent on other microorganisms on fruit, (4) determining modes of action, (5) economic feasibility (cost, market potential, range of activity, patent potential), (6) potential pathogenicity to humans or other commodities, (7) public acceptance, and (8) potential for pathogens developing resistance to biocontrol agents (Janisiewicz 1988, 1991; Wilson and Wisniewski 1989; Wilson et al. 1991; Wisniewski and Wilson 1992).

This brings us to the ultimate challenge for biocontrol researchers: Develop biocontrol agents that are as effective as fungicides and are safer for humans and the environment.

#### References and Literature Cited

- Baker, K. F. 1987. Evaluating concepts of biological control of plant pathogens. *Annu. Rev. Phytopathol.* 25:67-85.
- Hofstein, R., Droby, S., Chalutz, E., Wilson, C. L., and Friedlander, B. 1991. Scaling-up the production for application of an antagonist - From basic research to R & D. *Biological Control of Postharvest Diseases of Fruits and Vegetables, Workshop Proc., Shepherdstown, West Virginia, Sept. 1990. U.S. Dept. Agr.-Sgr. Res. Serv. Publ.* 92:197-210.
- Janisiewicz, W. 1988. Biological control of diseases of fruits. In: K. J. Mukerji and K. L. Garg (eds). *Biocontrol of Plant Diseases, Vol. II.* CRC Press, Boca Raton, FL, p. 153-165.
- Janisiewicz, W. 1991. Biological control of postharvest fruit diseases. In: D. K. Arora, B. Rai, K. G. Mukerji, and G. R. Knudsen (eds). *Handbook of Applied Mycology. Vol.1: Soils and Plants.* Marcel Dekker, Inc., New York, p. 301-326.
- Ko, W. H. 1971. Biological control of seedling root rot of papaya caused by *Phytophthora palmivora*. *Phytopathology* 61:780-782.
- Ko, W. H. 1982. Biological control of *Phytophthora* root rot of papaya with virgin soil. *Plant Dis.* 66:446-448.
- McLaughlin, R. J., Wisniewski, M. E., Wilson, C. L., and Chalutz, E. 1990. Effect of inoculum concentration and salt solutions on biological control of postharvest diseases of apple with *Candida* sp. *Phytopathology* 80:456-461.
- Pusey, P. L. and Wilson, C. L. 1984. Postharvest biological control of stone fruit brown rot by *Bacillus subtilis*. *Plant Dis.* 68:753-756.
- Pusey, P. L., Hotchkiss, M. W., Dulmage, H. T., Baumgardner, R. A., Zehr, E. I., Reilly, C. C., and Wilson, C. L. 1988. Pilot tests for commercial production and application of *Bacillus subtilis* (B-3) for postharvest control of peach brown rot. *Plant Dis.* 72:622-626.
- Pusey, P. L., Wilson, C. L., Hotchkiss, M. W., and Franklin, J. D. 1986. Compatibility of *Bacillus subtilis* for postharvest control of peach brown rot with commercial fruit waxes, dicloran, and cold-storage conditions. *Plant Dis.* 70:587-590.
- Stanley, D. 1993. Fighting fruit decay nature's way. *Agricultural Research.* 41(8):14-15.
- Wilson, C. L. and Pusey, P. L. 1985. Potential for biological control of postharvest plant diseases. *Plant Dis.* 69:375-378.
- Wilson, C. L., and Wisniewski, M. E. 1989. Biological control of postharvest diseases of fruits and vegetables: an emerging technology. *Annu. Rev. Phytopathol.* 27:425-441.
- Wilson, C. L., Wisniewski, M. E., Biles, C. L., McLaughlin, R., Chalutz, E., and Droby, S. 1991. Biological control of post-harvest diseases of fruits and vegetables: alternatives to synthetic fungicides. *Crop Protection* 10:172-177.
- Wisniewski, M. E., and Wilson, C. L. 1992. Biological control of postharvest diseases of fruits and vegetables: recent advances. *HortScience* 27:94-98.

Reference to company and/or product names is only for purposes of information and does not imply approval or recommendation of the product by the U. S. Department of Agriculture to the exclusion of others which may also be suitable.

**Table 1. Reports of postharvest biological control (Wisniewski and Wilson 1992).**

Biocontrol agent	Commodity	Disease	Reference year
<b>Bacteria</b>			
<i>Pseudomonas syringae</i>	Apple	Blue mold	1987
<i>P. cepacia</i>	Apple	Blue mold	1988
	Apple	Gray mold	1988
	Apple	Mucor rot	1987
	Pear	Blue mold	1988
	Pear	Gray mold	1988
<i>P. gladioli</i>	Pear	Gray mold	1989
<i>Bacillus subtilis</i>	Citrus	Green mold	1984
	Citrus	Sour rot	1984
	Citrus	Stem end rot	1984
	Nectarine	Brown rot	1984
	Peach	Brown rot	1984
	Apricot	Brown rot	1984
	Plum	Brown rot	1984
	Cherry	Brown rot	1986
<i>Enterobacter cloacae</i>	Peach	Rhizopus rot	1987
<i>E. aerogenes</i>	Cherry	Alternaria rot	1986
<b>Yeasts</b>			
<i>Pichia guilliermondii</i>	Apple	Blue mold	1990
	Apple	Gray mold	1988, 1990
	Citrus	Green mold	1989, 1990
	Citrus	Blue mold	1990
	Citrus	Sour rot	1990
	Grape	Gray mold	1988
	Grape	Rhizopus rot	1988
<i>Cryptococcus</i> spp.	Apple	Blue mold	1991
<i>C. laurentii</i>	Apple	Gray mold	1990
	Pear	Mucor rot	1990
<i>C. flavus</i> , <i>C. albidus</i>	Apple	Gray mold	1991
	Pear	Mucor rot	1990
<b>Fungi</b>			
<i>Acremonium breve</i>	Apple	Gray mold	1988
<i>Trichoderma</i> sp.	Citrus	Sour rot	1983
	Strawberry	Gray mold	1977
<i>T. harzianum</i>	Grape	Gray mold	1984
Attenuated strains of <i>Penicillium</i> sp.	Pineapple	Penicillium rot	1980

**Table 2. Biological control of postharvest diseases of fruits and suggested modes of action (Wilson and Wisniewski 1989).**

Commodity	Disease	Antagonist	
<b>Antibiotic production</b>			
Apple	Blue mold	<i>Pseudomonas cepacia</i>	
	Mucor rot		
Apricot	Brown rot	<i>Bacillus subtilis</i>	
Cherry	Brown rot	"	
	Alternaria rot	<i>Enterobacter aerogenes</i>	
Citrus	Stem end rot	<i>B. subtilis</i>	
	Sour rot	"	
	Green mold	"	
	Sour rot	<i>Trichoderma</i> sp.	
Nectarine	Brown rot	<i>B. subtilis</i>	
Peach	Brown rot	<i>B. subtilis</i>	
Pear	Blue mold	<i>P. cepacia</i>	
	Gray mold	"	
Plum	Brown rot	<i>B. subtilis</i>	
<b>Nutrient competition (N) and/or induced host resistance (HR)</b>			
Apple	Blue mold	<i>P. syringae</i>	(HR)
	Gray mold	<i>Acremonium breve</i>	(HR)
	Gray mold	<i>Debaryomyces hansenii</i> (= <i>Pichia guilliermondii</i> )	(N + HR)
Citrus	Green mold	"	"
	Blue mold	"	"
	Sour rot	"	"
Grapes	Gray mold	"	(N)
	Rhizopus rot	"	(N)
Peach	Rhizopus rot	<i>E. cloacae</i>	(N)

**Table 3. Issued or pending patents for biocontrol microorganisms (Wilson et al. 1991).**

Biocontrol agent	Commodity	Disease	Reference
<b>Bacteria</b>			
<i>Bacillus subtilis</i>	Stone fruit	Brown rot	Pusey & Wilson 1988
<i>Pseudomonas cepacia</i>	Pome fruit	Botrytis rot Penicillium rot	Janisiewicz & Roitman 1988
<b>Fungi</b>			
<i>Acremonium breve</i>	Pome fruit	Botrytis rot	Janisiewicz, 1988
<b>Yeasts</b>			
<i>Pichia guilliermondii</i>	Citrus	Various rots	Wilson & Chalutz 1989
	Stone fruit		
	Pome fruit	Chalutz & Wilson 1990	
<i>Hanseniaspora uvarum</i>			

# Papaya Fungicide Research Update

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Because of the combination of high susceptibility of the papaya cultivars grown in Hawaii and the environmental conditions being highly conducive for disease development, the Hawaii papaya industry must continue to rely on fungicides to economically produce a crop. The industry still relies heavily on mancozeb for the prevention of the major postharvest fruit diseases as well as blight caused by *Phytophthora palmivora*.

Although mancozeb was reinstated for use on papaya in February 1992, there is still concern for residues of ethylene bisdithiocarbamate (EBDC) and ethylene thiourea (ETU) on sprayed papayas. One area of work we have been involved in was to identify chemicals that papaya fruits could be treated with to reduce the levels of EBDC and ETU. Sodium hydroxide, sodium carbonate, sodium hypochlorite (Clorox), EDTA, and calcium hypochlorite were found to be safe to use in a five-minute dip at 8,000 ppm. A preliminary test using 1,000 ppm of calcium hypochlorite reduced the EBDC level by about 65 percent. Reduction of ETU levels was not determined.

## Alternatives to Mancozeb

**Anilazine (Dyrene).** Anilazine was, until recently, registered for strawberries, green onions, celery, tomatoes, potatoes, and a number of other food products. Although it does not have activity against phytophthora, it has good activity against colletotrichum (anthracnose). In field trials, anilazine looked good, but it began to show phytotoxic effects after the sixth week at 1 lb and 2 lb per acre applied once every 14 days. The manufacturer recently canceled all Dyrene registrations.

**Chlorothalonil (Bravo).** Chlorothalonil is still registered for use on papaya but sprayed fruits have a tendency to become scalded when exposed to quarantine heat treatments. Three different

formulations (Bravo W75, Bravo 720, and ASC 66518) were tested under field conditions at Malama-ki Research Station but all three formulations caused scalding when treated fruits were vapor-heat treated. The Bravo W75 caused the least scalding. Two safeners, "Red Top" and UAP-M9911 were tested under field conditions to neutralize the scalding effects of chlorothalonil. Neither of these two products proved effective in reducing scalding.

**Metaxyl-copper (Ridomil-copper).** The protocol for residue testing was finally approved by the IR-4 in September 1993. The manufacturer, Ciba-Geigy Corp., also approved the protocol but directed that the number of applications be reduced from six to four during any 26-week period. Residue studies should begin during the summer of 1994.

**Fluazinam.** Earlier testing identified fluazinam as a possible alternative to mancozeb because of its broad-spectrum activity. It is non-systemic, has activity against phytophthora and colletotrichum (and many other fungi), but it does not have any food crop registration yet. Field tests at Malama-ki Research Station showed it to be less effective against anthracnose than mancozeb or chlorothalonil. Beginning about the sixth week after the start of spraying, fruits began to show phytotoxic symptoms. Symptoms consisted of small, dark, depressed spots on the fruit surface.

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# Ecology of *Bactrocera latifrons* Populations in Hawaii

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The frugivorous tephritid fruit fly complex in Hawaii consists of four known species introduced at various times over the past century: the melon fly, *Bactrocera cucurbitae* (Coquillett), in 1895; the Mediterranean fruit fly, *Ceratitis capitata* (Wiedemann), in 1910; the oriental fruit fly, *Bactrocera dorsalis* (Hendel), in 1945; and *Bactrocera latifrons* (Hendel), about 1983. The presence of this pest complex has imposed strong constraints on the development and diversification of agriculture in Hawaii and has provided a large reservoir of unwanted and increasingly frequent introductions of fruit flies into the continental United States. Because of their polyphagous feeding habits and ecological adaptiveness, these fruit flies continue to threaten the multi-billion dollar fruit and vegetable industry of the southern-situated states of the contiguous United States. Many aspects of the biology and ecology of melon fly, oriental fruit fly, and Mediterranean fruit fly that are necessary in the suppression and eradication of these species have been well studied. On the contrary, because of the "less economic importance" status of *B. latifrons*, biological information necessary for population management, suppression, and eradication is not available.

*B. latifrons* is native to South and Southeast Asia, and has been recorded in China, Hawaii, India, Laos, Malaysia, Pakistan, Sri Lanka, Taiwan, and Thailand. Following its detection in Honolulu in 1983, it was reported to be confined to the island of Oahu, with a narrow range of host plants. Subsequent life history studies showed that *B. latifrons* has a much lower reproductive potential than other dacine pests found in Hawaii, and was deemed less competitive than oriental fruit fly, melon fly, and Mediterranean fruit fly. Recent surveys revealed that *B. latifrons* is distributed on all of the accessible, major islands of the Hawaiian chain.

This paper summarizes information on host plants of *B. latifrons* and some ecological attributes of *B. latifrons* populations in Hawaii.

Table 1 summarizes the infestation intensity of *B. latifrons* in 11 solanaceous and 4 cucurbitaceous

host plants. On the island of Hawaii, *Solanum nigrum* L. yielded the highest number of *B. latifrons* per 100 g of infested fruit, followed by *Capsicum annuum* L., *Lycopersicon Lycopersicum* cv. *cerasiforme* (Dunal), *Capsicum frutescens* L., *Solanum pseudocapsicum* L., *Solanum nigrescens* Mart. & Galleotti, *Physalis peruviana* L., *Lycopersicon pimpinellifolium* (Jusl.) Mill., *Coccinea grandis* (L.) Voigt, and *Solanum melongena* L. *Benincasa hispida* (Thunb.) Cogn., *Cucumis sativas* L., and *Lagenaria siceraria* (Mol.) had very low levels of infestation by *B. latifrons*. On the island of Maui, *Solanum torvum* Sw., *L. Lycopersicum* cv. *cerasiforme*, and *L. pimpinelli-folium* had the highest number of *B. latifrons* larvae per 100 g of fruit.

Based on infestation intensity data (number of larvae per 100 g fruit and percentage collections with *B. latifrons* infestation) and intensity of collections (directly proportional with the available host biomass during the conduct of the study), I contend that the most important host plants of *B. latifrons* in feral habitats in Hawaii are *L. pimpinellifolium*, *S. sodomium*, *S. nigrum*, and *S. torvum*. *Capsicum* spp., *L. Lycopersicum*, and *S. melongena* appear to be the most favored host plants under commercial cultivation and dooryard situations.

The following generalizations can be made on the ecological attributes of *B. latifrons* and their adaptive significance in establishing widespread populations in a new geographic area, like Hawaii:

First, *B. latifrons* is able to complete a generation in approximately 20 days. Thus, a colonizing population depending on host availability and weather conditions has a high probability of establishment in a new area.

Second, *B. latifrons* females mate early, have a short preoviposition period, and lay few eggs per day over a relatively long oviposition period. This means that the total number of eggs can be quite numerous but well distributed over the females' adult life. Ecologically, it translates to an efficient allocation or use of host resource that may maximize the rate of reproductive success (i.e., less competition among cohorts resulting in more

**Table 1. Host plants of *Bactrocera latifrons* (Hendel) on Hawaii and Maui.**

Family		Total fruits	<i>B. latifrons</i> /100 g fruit	
Scientific name	Common name; fruit position	collected	Mean	Std. error
<b>HAWAII</b>				
<b>Solanaceae</b>				
<i>Capsicum annuum</i> L.	Chili, bell, sweet, cayenne peppers			
	fruit on shrub	5066	30.09	15.59
	fruit on ground	1231	13.91	6.25
<i>C. frutescens</i> L.	Tabasco, bush red peppers	2180	18.99	
<i>Lycopersicon Lycopersicum</i> (L.) Karst. ex Farw.	Common tomato; fruit on shrub	541	1.09	0.70
	fruit on ground	403	7.54	
<i>L. L. cv. cerasiforme</i> (Dunal)	Cherry tomato; fruit on shrub	1715	20.02	19.88
	fruit on ground	1477	0.32	0.21
<i>L. pimpinellifolium</i> (Jusl.) Mill.	Currant tomato	1946	3.09	1.16
<i>Physalis peruviana</i> L.	Poha	1351	3.41	
<i>Solanum melongena</i> L.	Common eggplant; fruit on shrub	567	1.28	0.29
	fruit on ground	1169	0.40	0.12
<i>S. nigrescens</i> Mart. & Galeotti	Dull popolo	552	5.46	
<i>S. nigrum</i> L.	Popolo	10,476	37.32	16.97
<i>S. pseudocapsicum</i> L.	Jerusalem cherry	1681	10.89	5.67
<i>S. sodomium</i> L.	Sodom apple	9853	2.64	0.58
<b>Cucurbitae</b>				
<i>Benincasa hispida</i> (Thunb.) Cogn.	Tunka, tankoy, zit-kwa	12	0.63	
<i>Coccinea grandis</i> (L.) Voigt	Ivy gourd, scarlet-fruit gourd	313	2.79	
<i>Cucumis sativus</i> L.	Cucumber	14	0.09	
<i>Lagenaria siceraria</i> (Mol.) Standl.	Ipu, upu	3	0.10	
<b>MAUI</b>				
<b>Solanaceae</b>				
<i>Lycopersicon Lycopersicum</i>	Common tomato	246	0.18	
<i>L. L. cv. cerasiforme</i>	Cherry tomato; fruit on shrub	462	0.34	
	fruit on ground	543	1.37	
<i>L. pimpinellifolium</i>	Currant tomato	249	1.34	
<i>Solanum melongena</i>	Common eggplant; fruit on shrub	344	0.44	
	fruit on ground	571	0.08	
<i>S. sodomium</i>	Sodom apple	5451	0.08	
<i>S. torvum</i> Sw.	Turkey berry	3273	0.92	

individuals reaching reproductive, adult stage).

Third, *B. latifrons* has a limited host range. Validated (i.e., with field infestation data) host plants of *B. latifrons* mostly belong to the families Solanaceae and Cucurbitaceae. Existence under natural field conditions with a limited host range may have adapted *B. latifrons* life history traits to periods of reduced host availability.

Fourth, *B. latifrons* maintains a relatively low population density even when available host biomass is abundant. This biological attribute is probably related to the fact that *B. latifrons* lays few eggs per day and that egg production remains constant irrespective of the cycle of host deprivation and host availability. Ecologically, this prevents *B. latifrons* from overusing or depleting

its food resource; thus, preventing any possibility of population "crash" and local extinction.

Fifth, *B. latifrons* is capable of establishing population clusters in marginal habitats (e.g., arid and windswept range and ranch lands) where other tephritids are less or not successful. As shown in this study, *B. latifrons* is the dominant fruit feeder in wild hosts (such as *L. pimpinellifolium*, *S. nigrum*, *S. nigrescens*, *S. sordidum*, and *S. torvum*) that occur in disturbed, abandoned agricultural fields and less-managed

ranch lands.

I contend that the above ecological attributes will allow *B. latifrons* to colonize, compete, and establish in areas where suitable hosts are present and physical conditions tolerable, even when other fruit flies are present. It is therefore recommended that the current status of *B. latifrons* as a fruit fly of lesser economic importance be reevaluated and its potential threat to the agriculture of Hawaii and the mainland United States be carefully examined.

# Papaya Statistics

Homer Rowley  
Hawaii Agricultural Statistics Service  
Hawaii Department of Agriculture

The Hawaii Agricultural Statistics Service (HASS) is responsible for the collection and dissemination of statistical data for the state's papaya crop. In that regard, HASS publishes a monthly report as well as comprehensive annual statistics. The monthly release concentrates on utilization, acreage, and preliminary prices. The annual statistics include the average number of farms, harvested acreage, and utilization, price, and value of production. Additionally, monthly historical data are also displayed (see Appendix Tables 1-3 and Figure 1). I will go over the annual statistics for 1992 before moving on to other aspects of HASS's papaya estimating program.

## Annual Statistics

Appendix Tables 4 and 5 will appear in the annual *Statistics of Hawaiian Agriculture*, 1992, which will go to print before the end of September, 1993. We have crammed just about all we can into these tables, so it takes a while to digest it all.

In Appendix Table 4 the really important figures are in the top portion, particularly the utilized production, price, and value. Despite the good production year, a reduction of 8.3¢ per pound in the fresh price was more than enough to offset a 29 percent increase in production, thus limiting the value of production. Utilized production totaled 71.3 million pounds, about in line with most years in the five-year period. However, the telling figure is the large amount processed papaya (15.5 million lb and highest on record), more than double the 1991 total, and that amount brought only 3¢ per lb to growers and is the main reason that the value of production wasn't higher. Appendix Table 5 contains monthly acreage, utilization, and price statistics for the five-year period. Annual acreage is an average of the 12 months.

Figure 2 shows the total fresh utilization for the past five years. The highest fresh utilization for the period was in 1989 when 64 million pounds of fresh papayas were sold. Prices were lower than a year earlier: 25¢ for fresh utilization compared with 33¢ for 1991. The bottom line is that the crop is valued at \$14.4 million, down 11 percent.

## Distribution

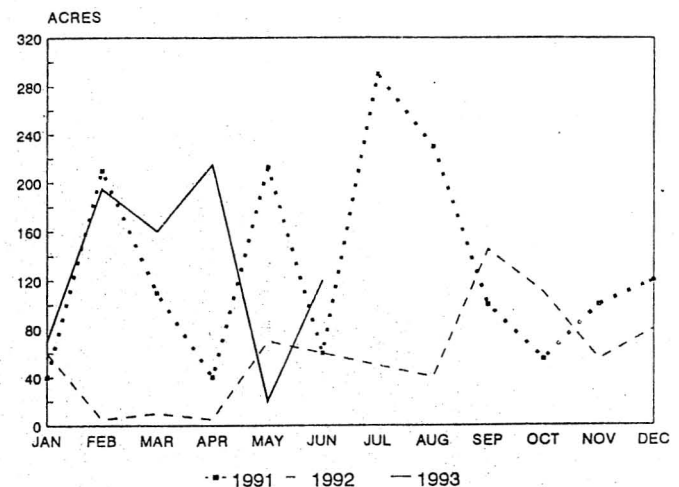
As everyone knows, the overwhelming majority of papayas are grown on the Big Island, but that doesn't mean the rest of the islands aren't making waves.

**Table 1. Papaya utilized production, by island, 1988-92.**

Year	1988	1989	1990	1991	1992
	Percent				
Hawaii	96.2	97.4	97.9	97.0	96.0
Kauai	2.0	1.3	1.2	1.3	1.6
Maui/Molokai	0.1	0.2	0.3	0.4	0.3
Oahu	1.7	1.1	0.6	1.4	2.1
State	100.0	100.0	100.0	100.0	100.0

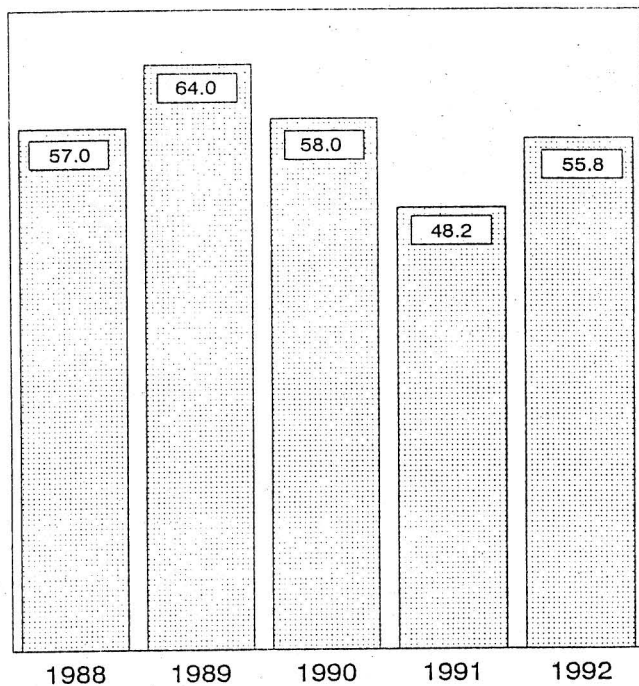
## Kauai

You may have heard the old saying that there are lies, damn lies, and statistics. You may also have heard of the book *How to Lie With Statistics*. This is a good example. Kauai experienced a 63 percent increase in their 1992 production, and still lost their entire crop to Hurricane Iniki. For the record, acreage was up some, but yields averaged 8,200 pounds per acre more than a year earlier. Lower prices kept the value down.

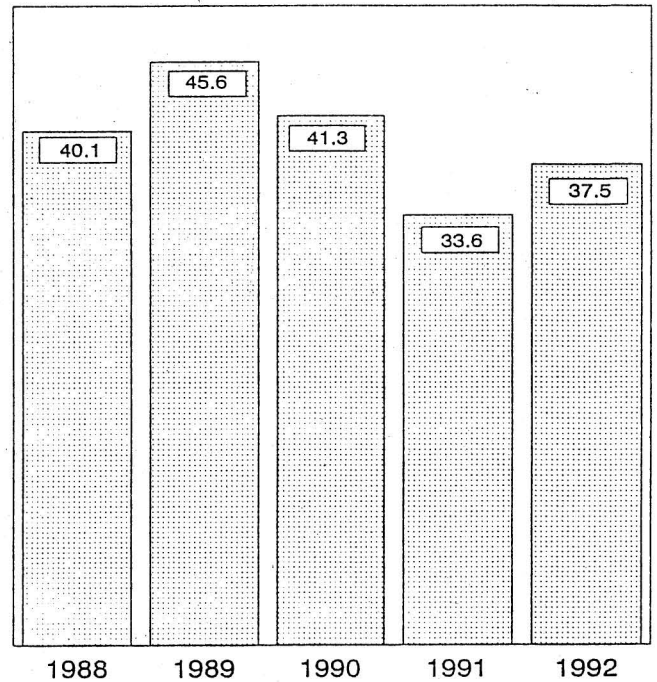


**Figure 1. State papaya acreage planted, 1991-1993.**

MILLION POUNDS

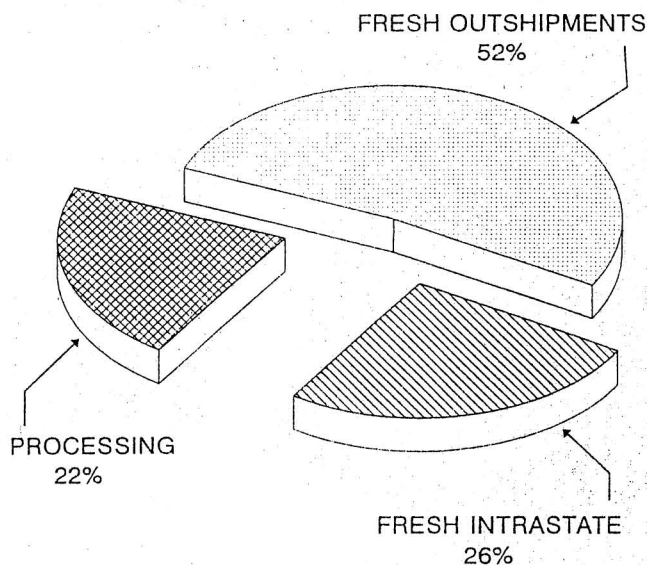


MILLION POUNDS



**Figure 2. Total fresh papaya utilization, State of Hawaii, 1988 – 1992.**

**Figure 4. Fresh papaya outshipments, State of Hawaii, 1988 – 1992.**



**Figure 3. Utilized papaya production, State of Hawaii, 1992.**

#### Oahu

Production nearly doubled in 1992 on the strength of a substantial boost in acreage and a higher yield. Like Kauai, prices were lower which tempered the increase in value.

#### Maui/Molokai

Statistically, very stable in 1992. Disclosure prevents the publication of individual data.

Looking at the distribution of utilized production and value, it is easy to see how much the Big Island dominates the industry, but the two charts for production and value show that Kauai and Oahu made their best showing of the past five years in 1992.

Table 2 illustrates island breakdowns for the value of utilized production for the past five years. The same relationships exist as for the utilized production total. Kauai and Oahu show up better here because average prices on these two islands were higher than the Big Island.

Another way of looking at the 71.3 million pounds of utilized production is the pie chart (Figure 3) which indicates the portion shipped



**Table 2. Papaya value of utilized production, distribution by island, 1988-92.**

Year	1988	1989	1990	1991	1992
	Percent				
Hawaii	94.4	96.2	96.5	95.2	92.6
Kauai	3.0	2.0	2.4	2.3	3.0
Oahu	2.6	1.8	1.1	2.5	4.4
State	100.0	100.0	100.0	100.0	100.0

fresh out of the state, amount processed, and local fresh sales.

Out of the total production were 55.8 million pounds that were sold fresh. The bar chart (Figure 2) indicates that the 1992 totals were nearly the same as two other years for the five-year period.

#### Outshipments

Figure 4 indicates that outshipments follow the same pattern as the fresh utilization, as the percent of fresh utilization that is shipped out of state stays fairly constant for three of the five years. During the five-year period the rate varied from 67 to 71 percent. Outshipments have trended downward during the past several years, with the lost outshipment tonnage being consumed mostly in Hawaii.

#### Outshipments by Destination

Virtually all outshipments are to the mainland U.S., Japan, and Canada. Table 3 shows how the 37.5 million pounds shipped out of state were allocated in 1992. There were an additional 15,000

**Table 3. Papaya outshipments by destination, 1992.**

Destination	Million lb	Percent
Mainland	20.9	56
Canada	4.3	11
Japan	12.3	33
Total	37.5	100

Source: Papaya Administrative Committee

lb not shown that went to "other destinations."

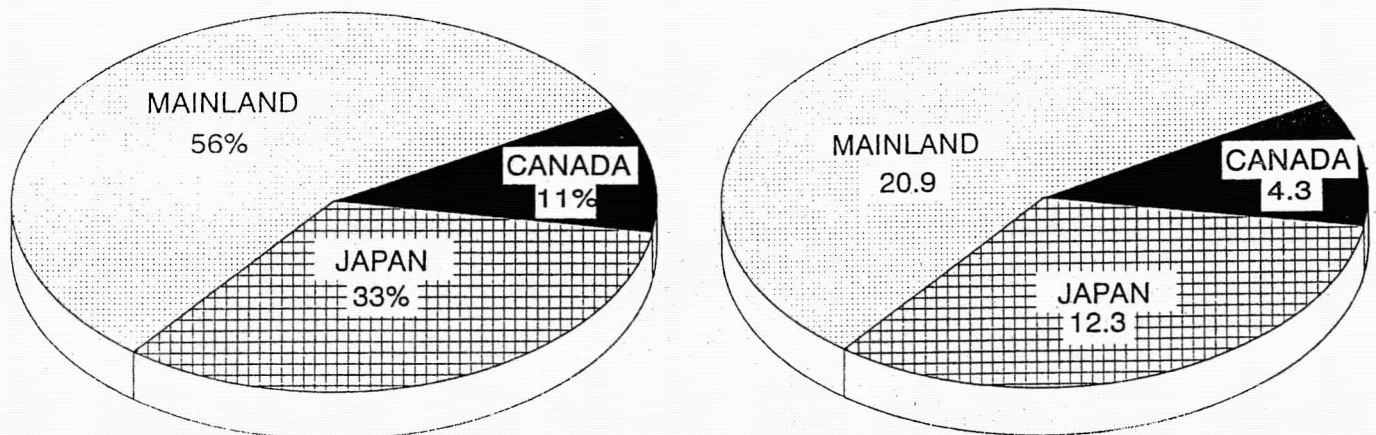
Figure 5 quantifies the amounts discussed above. The second pie chart, Figure 6, shows the same data but expressed in percentages.

#### Imports

It is difficult to get a line on actual imports, as the U.S. Department of Commerce wants about \$2,300 to subscribe to their quarterly CD-ROM import/export data, and I'm having a hard time convincing NASS to come up with the money. I'm requesting them to negotiate an agency-wide subscription in headquarters to help us and other NASS state offices share the cost.

Total imports of papayas and papaya products amounted to \$10.2 million in 1992. This included \$6.7 million of fresh papayas, most of which came from Mexico, although there were some Caribbean countries involved as well. The other \$3.5 million came from dried, pulp, frozen, puree, and other preparations and preserves.

I think we can safely say that Mexico is a major competitor of Hawaii papayas, and this will



**Figure 5. Papaya outshipments by destination; percent distribution (left) and million pounds (right).**

probably not diminish, especially with the coming of NAFTA. Mexico, from which the U.S. imported one third of all its fresh fruit and vegetable imports, will probably pose stiff competition in the Canadian market too.

#### **Papaya Objective Yield Survey**

We have been conducting this survey on the Big Island to set current production levels for nearly 20 years in partnership with the PAC. To conduct the survey, HASS makes tree and fruit counts in 80 randomly selected orchards at 14-day intervals. The counts are expanded in a model to arrive at a production forecast. Tree counts are made each quarter by laying out a 21 x 21 ft square (approximately .01 acre) and counting the trees in the square. This expansion accounts for the trees that have been lost due to disease, roguing, or storms. The listing summarizes the survey and includes limitations. The partnership with the PAC involves the commitment of resources by both the PAC and HASS. Under this agreement HASS provides:

Maintenance, repairs, garage for PAC pick-up truck,

Research statistician in Honolulu,

Three papaya research aides on Big Island.

In return, the PAC provides:

Pick-up truck lease and insurance,

Field person to identify new growers and locate fields for the Papaya Objective Yield Survey.

Limitations of the survey:

Fruit ripens at differing rates during the year:

Cold: Fruit ripens slower,

Hot: Fruit ripens faster,

Wet followed by hot: Produces skip.

Fruit drop rates are uneven throughout the year.

Only as good as list-building activities for new growers and fields.

We cannot stress enough how important the PAC fieldperson is to the survey. Without this assistance, our producer lists would deteriorate to the point where we could not select a statistically reliable sample for the Objective Yield Survey and we would not be able to continue the survey operations.

## Papaya Statistics -- Appendix Table 1

# HAWAII PAPAYAS



HAWAII



AGRICULTURAL  
STATISTICS  
SERVICE

Hawaii Department of Agriculture  
U.S. Department of Agriculture

Box 22159, Honolulu, HI 96823-2159  
(808) 973-9588  
FAX (808) 541-3495

Frequency: Monthly  
Release: September 10, 1993

### HIGHLIGHTS:

- **AUGUST FRESH SALES ESTIMATED AT 4.8 MILLION POUNDS**
- **FRESH FARM PRICE PEGGED AT 23.0 CENTS PER POUND**

Fresh papaya production from Hawaii is estimated at 4.8 million pounds for August, 8 percent lower than July but 20 percent higher than August 1992. Year-to-date fresh sales were 1 percent lower than the same 8-month period a year ago.

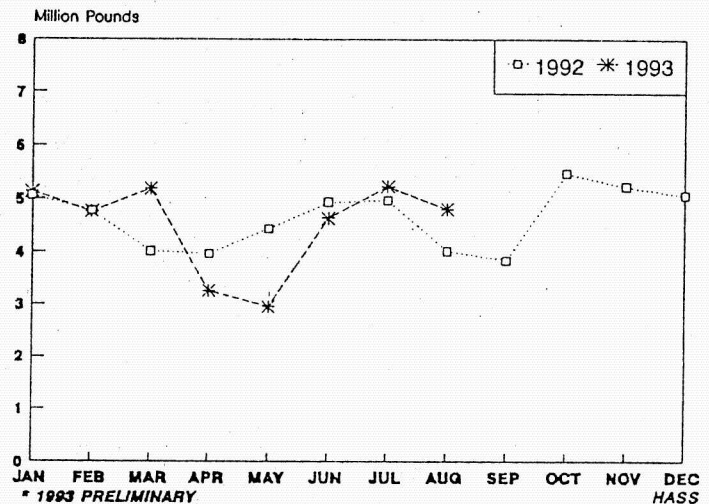
Weather conditions were mixed in August. Sunny skies prevailed during the first and last weeks of August. Showers, heavy at times, and gusty winds occurred at mid-month as two hurricanes passed close to the State.

Area devoted to papaya production is pegged at 3,815 acres, virtually unchanged from last month but 5 percent more than a year ago. Harvested area, totaling 2,575 acres, remained nearly unchanged from July but was 1 percent lower than last August.

Papaya growers are expected to receive an estimated 23.0 cents per pound in August, 5 percent (1.0 cents) higher than July but 1 percent (0.3 cents) lower than a year ago.

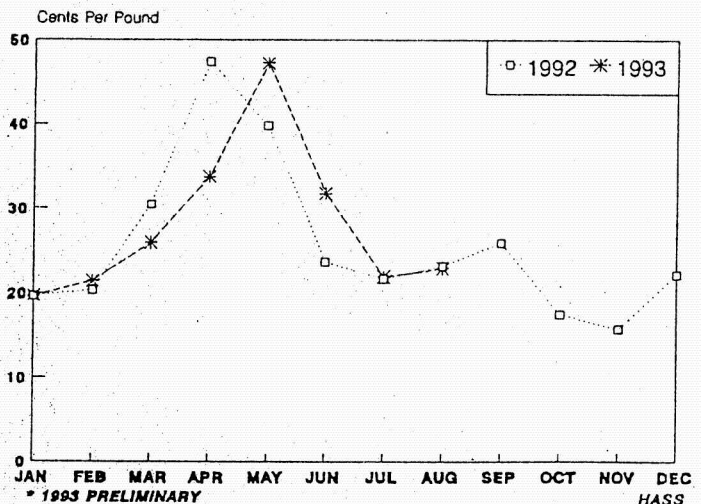
### FRESH PAPAYA UTILIZATION

STATE OF HAWAII, 1992-93\*



### FRESH PAPAYA FARM PRICE

STATE OF HAWAII, 1992-93\*



## Papaya Statistics – Appendix Table 2

### FRESH PAPAYA UTILIZATION, MONTH OF: August 1993

Island	Sales				Year ago	Year-to-date	
	Local <sup>1</sup>	Intrastate	Out-of-State	Total fresh		1992	1993
	1,000 pounds						
Hawaii.....	158	1,052	3,390	4,600	3,740	33,975	34,695
Kauai .....	19	6	0	25	135	1,085	40
Maui/Molokai/Oahu <sup>2</sup> ....	175	15	0	190	140	1,120	1,250
State.....	352	1,073	3,390	4,815	4,015	36,180	35,985

<sup>1</sup> On island of production.

<sup>2</sup> Combined to avoid disclosure of individual operations.

### PAPAYA ACREAGE INVENTORY AS OF: August 1993

Island	Acreage planted in July 1993	Acreage harvested				Acreage for harvest Sep. 1993	Total acreage in crop	
		August 1993			Sep. 1992		Aug. 1, 1992	Aug. 1, 1993
		1 <sup>st</sup> year of harvest	2 <sup>nd</sup> year of harvest	Total				
		Acres						
Hawaii.....	NA	1,125	1,300	2,425	2,585	2,445	3,390	3,525
Kauai .....	NA	15	0	15	60	20	95	95
Maui/Molokai/Oahu .....	NA	115	20	135	110	150	140	195
State .....	NA	1,255	1,320	2,575	2,755	2,615	3,625	3,815

NA = Not available.

### FRESH PAPAYA FARM PRICE

Year and place of sale		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Average
		Cents per pound												
1992	All .....	19.7	20.4	30.5	47.5	39.8	23.7	21.8	23.3	26.0	17.6	15.8	22.3	25.0
	Local .....	23.6	25.1	30.0	45.2	32.0	25.0	24.6	25.0	34.5	20.2	16.4	26.9	
	Mainland.....	16.8	15.8	25.1	42.4	42.5	<sup>2</sup> 23.2	<sup>2</sup> 20.7	<sup>2</sup> 22.6	<sup>2</sup> 21.8	<sup>2</sup> 16.2	<sup>2</sup> 15.4	<sup>2</sup> 19.7	
	Foreign .....	19.4	21.1	35.3	54.1	44.1	<sup>2</sup>	<sup>2</sup>	<sup>2</sup>	<sup>2</sup>	<sup>2</sup>	<sup>2</sup>	<sup>2</sup>	
1993 <sup>1</sup>	All .....	19.7	21.5	26.0	33.8	47.3	31.8	22.0	23.0					
	Local .....	23.5	22.3	29.4	39.5	52.4	33.5							
	Mainland.....	<sup>2</sup> 17.3	<sup>2</sup> 21.0	<sup>2</sup> 23.8	<sup>2</sup> 31.0	<sup>2</sup> 44.4	<sup>2</sup> 30.9							
	Foreign .....	<sup>2</sup>	<sup>2</sup>	<sup>2</sup>	<sup>2</sup>	<sup>2</sup>	<sup>2</sup>							

<sup>1</sup> Preliminary.

<sup>2</sup> Mainland and foreign combined to avoid disclosure of individual operations.

## Papaya Statistics – Appendix Table 3

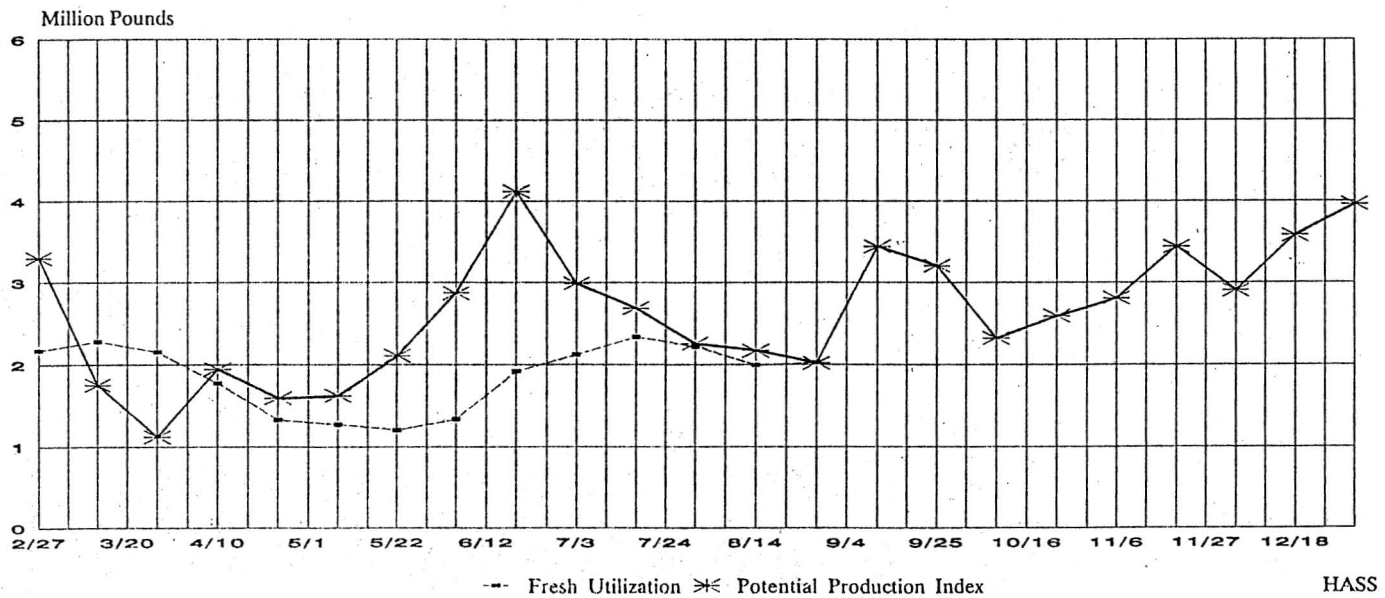
### BIWEEKLY HAWAII (BIG ISLAND) POTENTIAL PRODUCTION AND ACTUAL FRESH PAPAYA UTILIZATION

	LATEST BIWEEKLY PERIODS		
	August 1 - 14	August 15 - 28	Year-to-Date <sup>3</sup>
TOTAL POTENTIAL PRODUCTION <sup>1</sup> (000 units)	4,335	4,034	100,392
ACTUAL FRESH UTILIZATION <sup>2</sup> (000 pounds)	1,994	2,024	33,507
ACTUAL AS PERCENT OF POTENTIAL	46.0	50.2	33.4

<sup>1</sup> Represents the potential number of fruit (biological production units) which could be produced during specific two-week intervals. It does not take into account survival rate (fruit drop), thinning, grade out, and other factors which could affect the eventual quantity of actual fresh sales. Index values on the graph were calculated by dividing this number by 2 assuming an average fruit weight of 1 pound.

<sup>2</sup> Actual sales of fresh fruit. Processed fruit not included.

<sup>3</sup> Year-to-date commencing January 1, 1993.





**Papaya Statistics – Appendix Table 4**

# PAPAYAS

**PAPAYAS: Number of farms, acreage, yield, utilization, price, and value, by islands, 1988-92 <sup>1</sup>**

Year	Farms <sup>2</sup>	Acreage harvested <sup>2</sup>	Yield per acre <sup>3</sup>	Utilized production	Utilization		Price per pound			Value of utilized production
					Fresh	Processed	Fresh	Processed <sup>4</sup>	All	
	<i>Number</i>	<i>Acres</i>		<i>1,000 pounds</i>			<i>Cents</i>			<i>1,000 dollars</i>
<b>State</b>										
1988	305	2,300	30.0	69,000	57,000	12,000	21.0	3.2	17.9	12,354
1989	325	2,500	29.6	74,000	64,000	10,000	22.0	3.0	19.4	14,380
1990	311	2,400	28.5	68,500	58,000	10,500	25.0	2.9	21.6	14,805
1991	271	2,025	27.3	55,350	48,150	7,200	33.3	2.7	29.3	16,228
1992	259	2,415	29.5	71,300	55,800	15,500	25.0	3.0	20.2	14,415
<b>Hawaii</b>										
1988	250	2,172	30.6	66,358	54,635	11,723	20.7		17.6	11,656
1989	277	2,373	30.4	72,068	62,080	9,988	21.8		19.2	13,825
1990	266	2,280	29.4	67,045	56,545	<sup>7</sup> 10,500	24.7		21.3	14,282
1991	229	1,915	28.0	53,685	46,485	<sup>7</sup> 7,200	32.8		28.8	15,441
1992	213	2,275	30.1	68,455	52,955	<sup>7</sup> 15,500	24.3		19.5	13,350
<b>Kauai</b>										
1988	20	70	19.9	1,394	1,370	24	<sup>6</sup> 28.9		<sup>6</sup> 26.4	<sup>5</sup> 376
1989	18	65	15.1	982	970	<sup>6</sup> 12	<sup>6</sup> 28.9		<sup>6</sup> 28.7	<sup>5</sup> 289
1990	16	50	15.8	790	790	<sup>7</sup>	<sup>5</sup> 35.5		<sup>5</sup> 35.5	<sup>5</sup> 359
1991	16	40	17.4	695	695	<sup>7</sup>	<sup>5</sup> 42.3		<sup>5</sup> 41.7	<sup>5</sup> 387
1992	15	45	25.2	1,135	1,135	<sup>7</sup>	<sup>5</sup> 31.7		<sup>5</sup> 31.7	<sup>5</sup> 434
<b>Maui/Molokai</b>										
1988	5	8	7.5	60	60	0	<sup>6</sup>		<sup>6</sup>	<sup>5</sup>
1989	4	16	9.7	155	155	<sup>6</sup>	<sup>6</sup>		<sup>6</sup>	<sup>5</sup>
1990	5	30	7.3	220	220	0	<sup>5</sup>		<sup>5</sup>	<sup>5</sup>
1991	4	30	7.3	220	220	0	<sup>5</sup>		<sup>5</sup>	<sup>5</sup>
1992	5	30	7.8	235	235	0	<sup>5</sup>		<sup>5</sup>	<sup>5</sup>
<b>Oahu</b>										
1988	30	50	23.8	1,188	935	253	<sup>6</sup>		<sup>6</sup>	322
1989	26	46	17.3	795	795	<sup>6</sup>	<sup>6</sup>		<sup>6</sup>	266
1990	24	40	11.1	445	445	0	36.8		36.8	164
1991	22	40	18.8	750	750	0	53.3		53.3	400
1992	26	65	22.7	1,475	1,475	0	42.8		42.8	631

<sup>1</sup> Sum of island estimates may not add to State total due to rounding.

<sup>2</sup> Average of monthly estimates.

<sup>3</sup> Utilized production divided by acreage harvested.

<sup>4</sup> Island data not shown separately to avoid disclosure of individual operations.

<sup>5</sup> Maui and Molokai combined with Kauai to avoid disclosure of individual operations.

<sup>6</sup> Oahu, Maui and Molokai combined with Kauai to avoid disclosure of individual operations.

<sup>7</sup> Kauai combined with Hawaii to avoid disclosure of individual operations.

**Papaya Statistics – Appendix Table 5**

**PAPAYAS**

**PAPAYAS: Acreage, utilization, price, and outshipments, State of Hawaii, 1988-92**

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Total or average
<b>Harvested acres <sup>1</sup></b>													
1988	2,175	2,225	2,200	2,175	2,325	2,220	2,290	2,310	2,410	2,375	2,420	2,410	2,300
1989	2,450	2,295	2,360	2,345	2,410	2,480	2,495	2,505	2,550	2,625	2,735	2,745	2,500
1990	2,675	2,560	2,490	2,435	2,365	2,370	2,405	2,175	2,220	2,405	2,420	2,285	2,400
1991	2,165	2,035	2,020	1,905	1,925	1,880	1,950	2,080	2,095	2,070	2,060	2,115	2,025
1992	2,025	2,150	2,160	2,190	2,190	2,410	2,465	2,590	2,755	2,640	2,655	2,745	2,415
<b>Utilization (fresh and processed) - 1,000 pounds</b>													
1988	4,525	3,300	3,290	4,710	5,315	5,715	6,740	6,160	7,255	7,730	7,105	7,155	69,000
1989	5,355	4,980	5,760	6,900	6,420	6,580	6,110	6,210	5,865	6,760	6,905	6,155	74,000
1990	5,605	5,020	5,720	5,810	6,860	4,995	3,415	6,790	5,595	6,150	6,675	5,865	68,500
1991	5,285	3,890	3,525	4,200	3,760	3,420	3,670	3,590	5,015	6,445	5,885	6,665	55,350
1992	6,175	6,280	5,170	5,135	5,930	7,045	7,815	5,155	4,360	6,395	6,085	5,755	71,300
<b>Total fresh papaya utilization - 1,000 pounds</b>													
1988	4,030	3,000	3,100	4,340	4,340	4,580	5,470	4,930	5,820	5,835	5,665	5,890	57,000
1989	4,425	4,165	4,830	5,945	5,475	5,645	5,130	5,290	5,165	6,130	6,270	5,530	64,000
1990	5,005	4,480	4,840	4,780	5,120	4,285	3,145	6,160	4,815	5,170	5,555	4,645	58,000
1991	4,665	3,365	3,155	3,890	3,350	2,895	3,290	3,205	4,460	5,380	4,820	5,675	48,150
1992	5,055	4,785	4,010	3,960	4,445	4,940	4,970	4,015	3,835	5,475	5,235	5,075	55,800
<b>Intrastate fresh papaya utilization - 1,000 pounds</b>													
1988	1,165	971	1,034	1,360	1,443	1,415	1,532	1,548	1,559	1,593	1,638	1,617	16,875
1989	1,489	1,426	1,450	1,830	1,574	1,339	1,513	1,518	1,415	1,895	1,642	1,309	18,400
1990	1,720	1,310	1,505	1,620	1,410	930	895	1,405	1,300	1,510	1,555	1,515	16,675
1991	1,400	1,160	965	1,040	1,000	865	910	1,130	1,455	1,525	1,525	1,625	14,600
1992	1,560	1,590	1,415	1,505	1,345	1,340	1,330	1,210	1,265	1,940	1,990	1,800	18,290
<b>Outshipments of fresh papayas - 1,000 pounds</b>													
1988	2,865	2,029	2,066	2,980	2,897	3,165	3,938	3,382	4,261	4,242	4,027	4,273	40,125
1989	2,936	2,739	3,380	4,115	3,901	4,306	3,617	3,772	3,750	4,235	4,628	4,221	45,600
1990	3,285	3,170	3,335	3,160	3,710	3,355	2,250	4,755	3,515	3,660	4,000	3,130	41,325
1991	3,265	2,205	2,190	2,850	2,350	2,030	2,380	2,075	3,005	3,855	3,295	4,050	33,550
1992	3,495	3,195	2,595	2,455	3,100	3,600	3,640	2,805	2,570	3,535	3,245	3,275	37,510
<b>Farm price for fresh market sales (to all markets) - cents per pound</b>													
1988	18.9	28.6	39.2	36.0	22.8	20.4	18.8	18.2	16.3	15.3	14.9	16.8	21.0
1989	22.0	25.4	27.7	29.0	25.3	21.1	20.7	21.6	19.8	20.0	16.2	16.9	22.0
1990	21.2	22.3	26.7	33.0	23.3	35.9	42.3	23.7	18.1	20.9	20.6	20.4	25.0
1991	24.6	32.3	42.1	48.7	51.0	52.4	54.9	36.8	23.4	18.6	21.2	23.0	33.3
1992	19.7	20.4	30.5	47.5	39.8	23.7	21.8	23.3	26.0	17.6	15.8	22.3	25.0

<sup>1</sup> Total is average of monthly data.

# Federal Marketing Orders: Their History and Purpose

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Today I have been asked to give a quick review of federal marketing orders with respect to their purpose and their historical underpinnings. This is probably an appropriate time and place to do so, as papayas are the only crop in Hawaii with a federal marketing order, and a referendum is currently being conducted to determine if the order shall be continued. I will address the economic rationale for marketing orders in a historical context as well as the types of economic activities that are conducted under marketing orders. Whenever possible I will try make reference to your marketing order.

## Marketing Orders Defined

A marketing order is a legal mechanism under which regulations issued by the authority of the Secretary of Agriculture are binding on all handlers of the product in a specified geographical area. Market orders are initiated by, and implemented only after approval by, the affected growers. These orders are mandatory and, because of this, different from other forms of collective action in agricultural marketing.

The Agricultural Marketing Agreement Act (AMAA) of 1937, as amended, is the legislation that enabled the formation of marketing orders (Powers Nichols 1990). The date of passage is key to understanding the original rationale for the establishment of marketing orders. At this time in U.S. history, the country was still suffering from the effects of the great depression. It can be argued that agriculture was in worse condition than the rest of the economy. Furthermore, in the case of agriculture, the farm depression actually occurred in the early 1920s.

All of agriculture was affected, but fruit farmers were especially hard hit because of large plantings coming into production. The combination of large production and very low prices generated interest in attempting to regulate the quantity and quality of fruits and vegetables marketed. Some of the larger cooperatives attempted to do this in the 1920s; long-term success was not achieved, however, because not enough producers and handlers could

be induced to cooperate. The program was strictly voluntary. It was possible for those people who did not cooperate in the voluntary program to receive many of the same benefits. They became "free riders."

A consequence of the passage of the AMAA was the ability to eliminate free riders. Fruit growers were especially interested in pursuing market orders. The nature of the crops in combination with weather can lead to wide variations in yields, grades, sizes, and maturities. This in turn can lead to the development of a poor image at the retail level, and sales and prices would suffer. The variation in yields can lead to wide price swings, which can cause economic hardships on both producers and consumers and make economic planning very tenuous.

Marketing orders can be found in almost all parts of the U.S. but are more prevalent in the West and Southeast. It is also interesting to note the percentage of total market supply covered by the market orders in fruits and vegetables. They vary from 100 percent to less than 10 percent. In 1986-1988 the value of sales of fruit and vegetables sold under marketing orders was \$4.6 billion. In the case of Hawaii, papaya production accounted for 82 percent of total U.S. supply in 1987, and all production in Hawaii is covered by the order.

Marketing orders in fruits and vegetables are big business. To a large degree this was the intention of the original legislation. The original act of 1937 was intended by Congress to be a tool for farmers. Through the use of marketing orders, orderly marketing conditions could be established with the subsequent achievement of parity prices. More often the establishment of orderly marketing is cited as the primary purpose of a marketing order. However, it is clear that the act was also intended to increase and maintain producer incomes through higher prices.

Since its original passage the AMAA has been amended several times. Subsequent amendments indicate an expansion of objectives to include enforcement of quality standards, uniformity in packaging, market and product development, and

orderly flow of marketing throughout the season(s).

We will define orderly marketing as the stabilization of price and quantity over time. If this can be achieved, producer's risks can be lowered and the flow of resources or inputs used during the production and marketing activities can be evened out. Public benefits, those not isolated to participants in the marketing order, can also be achieved. Market information, generic promotions, research, and quality improvements can also bestow benefits to the general consuming public.

Under federal marketing orders, three basic categories of economic activities can be undertaken. It is important to note that not all marketing orders allow for implementation of all activities. Which activities can be undertaken by any particular marketing order is a function of federal legislation and the original petition submitted by producers. The three basic categories of economic activities are quality control, quantity control, and market facilitating activities.

Quality control regulations can include package and container requirements and grade and size standards. Quantity-control regulations can impose shipping holidays, prorates, market allocation, reserve pools, and marketing allotments. I will not spend much time discussing quantity controls as they are not used under the papaya marketing order. Market-facilitating regulations can authorize money to be collected to fund advertising and promotion as well as production, marketing, and product research. The papaya marketing order authorizes promotion, research, and package requirements as well as grade and size standards.

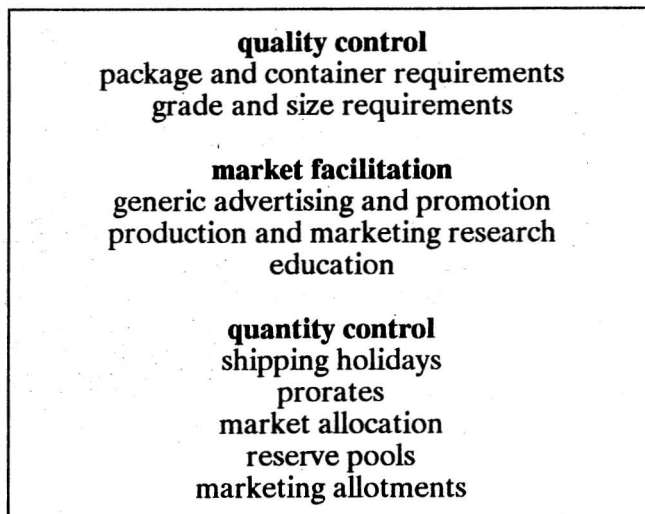
Figure 1 shows more specifically the activities possible under a federal marketing order. Since the act's initial passage and subsequent amendments, the activities allowed can be categorized as being pro-efficiency. Research has tended to focus on cost reduction in both marketing and production. Grades and sizes also facilitated the marketing of fruits and vegetables across wide distances without the need for visual inspection. To some extent, though, the activities undertaken under most marketing orders can also be categorized as enhancing product image and salability. It is clear that promotion and advertising are aimed at increasing peoples' awareness of the product and hence, increase sales.

Quality controls also are aimed at enhancing a product's image and protecting the industry's reputation. In many crops there is a temptation to

sell immature fruit so that a higher price may be attained. This strategy is short-sighted, because a poor product can ruin the market. In general, there may be temptation to sell less than superior quality, especially if a viable alternate market doesn't exist for the off-grade product. In today's fresh produce industry, with increasing competition among a growing variety of fruits and vegetables and a growing number of suppliers, lack of quality standards appears almost suicidal. It should be mentioned that quality controls can be used to affect the volume marketed in the short run. In times of gluts, standards may be increased, and vice versa when supplies are short.

### **Costs and Benefits of Marketing Orders from a Producer Perspective**

In discussing marketing orders it is useful to break down the basic costs and benefits of their implementation. First, I want to stress the mandatory nature of marketing orders. Once approved by a majority of the growers, all growers and handlers in the specified geographical area must abide by its regulations. That is, they must adhere to any quantity control, quality control, or market-facilitating regulations. This is not accidental. The need for federal legislation arose from the lack of participation when voluntary programs were attempted. The mandatory participation and subsequent elimination of free riders leads to most of the benefits and costs incurred by producers and handlers.



**Figure 1. Economic activities conducted under market orders.**

## Benefits

In Figure 2 I have identified some of the general benefits that can be attributed to marketing orders. Those specifically associated with quantity controls are not listed, as they are not relevant to your situation. I have listed elimination of free riders as number one, because it impacts the other benefits. Under the auspices of the administrative committee, producers can achieve economies of size which are unavailable to them as individuals. For instance, research can be funded that can address problems in marketing, production, and product development. For most farmers this would be impossible. It is my understanding that some of the work done on fruit flies has been funded by the Papaya Administrative Committee. Through the creation of grades and sizes requirements and packaging regulation, efficiency in marketing can be increased. Again, an individual farmer working alone would probably not be able to receive these benefits. Improved marketing efficiency can also lead to increased sales. Through an aggressive promotional program and high quality, a product's image at retail can be enhanced and, it is hoped, maintained. The implementation of a marketing order can lead to the generation of new and more varied information, which, in turn, can reduce the level of risk which a producer must face when making plans. Finally, though it is not listed, if the marketing order is successful one would assume that farmers' incomes would be enhanced and show more stability.

### benefits

- elimination of free riders
- economies of size
- research program
- efficiency in marketing
- improved image at retail
- more information
- less uncertainty

### costs

- loss of individual control
- assessment costs
- loss of flexibility

## Cost

The consequence of free rider elimination is that participants under a federal marketing order lose some of their individual decision-making power. They are required to adhere to all of the regulations as stipulated under the marketing order. This in turn reduces their flexibility. For example, a papaya producer or handler must follow the grade and size requirements. This reduces some of the options they might have otherwise faced. Finally, marketing orders require money to operate. This money is raised through an assessment. In general this assessment is small relative to the price received, but it is nonetheless a cost. Assuming the marketing order is successful, the financial costs of the assessment should be outweighed by the benefits received.

## Summary

I have purposely not covered the mechanics of implementing a federal marketing order, nor have I discussed the make-up or operation of the administrative committee. I believe this would be inappropriate at this time. Marketing orders were intended to address the economic plight of producers through the achievement of income stability and increased marketing efficiency. In many cases they have been remarkably successful. They were also intended to be essentially a self-help mechanism, although backed by legislative authority. As such, I believe, marketing orders play a vital role in U.S. agriculture. They do restrict individual freedom, but it is hard to conceive of their operation without mandatory participation. In the final analysis, one must examine the costs and benefits of implementing and maintaining a marketing order. In doing so, I believe it is imperative to have a long-run view and not just seek immediate monetary gain.

## Reference

Powers Nicholas, J. Federal marketing orders for horticultural crops. AIB-590. U.S. Dept. Agr., Econ. Res. Serv., March 1990.

Figure 2. Costs and benefits of market orders.



# Inspection Requirements for Papayas

Samuel Camp  
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I would like to discuss why the Department of Agriculture is involved with grading papayas under the Federal Papaya Marketing Order, what our requirements are, and what other services we provide.

The Hawaii Department of Agriculture has a Cooperative Agreement with the United States Department of Agriculture to conduct Fresh Fruit and Vegetable Certification. Under this cooperative agreement the USDA licenses state inspectors to inspect and certify fresh fruit and vegetables and provides training, certificate forms, and technical backup. The state in turn rebates a percentage of the fees charged to the USDA.

The Papaya Marketing Order specifies that any handler of papayas subject to grade, size, pack, or container requirements for any geographical area or market type shall have the papayas inspected and certified by the federal or federal-state inspection service to certify that they meet the requirements of such regulations. The Department of Agriculture therefore provides this service required by the Papaya Marketing Order when grade and size regulations are in effect. The Papaya Marketing Order currently requires that all papayas marketed in any market area shall meet the requirements of Hawaii No. 1 grade for papayas.

The Hawaii standards for grades of papayas were established by rule by the Hawaii Department of Agriculture in consultation with the papaya industry. These standards for grades may be changed through the Hawaii rule making process. Changes to official grades can take up to a year to complete. The Papaya Administrative Committee can, by regulation, specify different requirements for grade, size, etc., as long as they are not in violation of state laws or rules.

Grade standards for fresh produce emphasize external attributes such as cleanliness, color, surface defects, and shape as well as internal attributes such as maturity and decay. Grade standards pertain to readily observable attributes to enable wholesale and retail buyers to compare offers and enter into transactions without seeing the produce before delivery. Grades give the buyer a basis for seeking redress if the produce is not

specified by contract. Grades provide a convenient way to describe product attributes without having to specify separately each attribute. External attributes covered by grade standards may reveal much about internal quality characteristics, including extent of decay; for example, the tinge of yellow on papaya to indicate maturity.

Consumer preferences and satisfaction are ultimately at stake. A consumer that is not familiar with papayas should be first exposed to good quality fruit. A consumer that is familiar with papayas should be assured that every fruit is as good or better than the first one. Consistency of desirable attributes aids in gaining market share.

The Department provides copies of official grade standards to all interested parties free of charge. The department will teach farmers, packing houses, wholesalers, or retailers how to properly grade papayas, free of charge on a time-available basis.

The marketing specialists employed by the Department of Agriculture are professionals trained to inspect and certify a wide range of agricultural commodities and to enforce state laws and rules. In order to reduce costs to the industry and assure that a flexible supply of labor would be available for marketing orders, the Hawaii Legislature established a marketing order revolving fund and authorized the hiring of inspectors exempt from state civil service. The Marketing Order Inspectors are trained to inspect only one product and do not enforce laws or rules. They are therefore paid a lower hourly wage and allow a lower inspection fee to be charged to the industry. There are currently nine Marketing Order Inspectors and 23 professional inspectors employed by the state. There are currently no licensed inspectors on Molokai or Lanai.

The PAC is authorized to enter into an agreement with the inspection service concerning the costs of inspection and to collect the respective pro rata share from the handlers. The PAC has chosen not to do this and the inspection service charges an hourly rate to *completely cover its costs of providing the service*. The inspection fee is based upon the average salary of the Marketing Order Inspectors plus fringe benefits, vacation and sick

leave accumulation, operating costs, unemployment insurance, and federal rebate. This fee will be \$19.56 per hour effective October 1, 1993. The fee for regular civil service inspectors is based upon the same factors but no charge for operations or unemployment is included. This fee is currently \$24.24 per hour and is set by Hawaii Administrative Rules. Every effort is made to keep the professional time to a minimum. Charges are also made for travel time to and from the inspection site, mileage, overtime, and night differential if applicable.

A request for inspection must be made during normal working hours at least two hours before the time of inspection. The inspection service may refuse to conduct an inspection outside of this time frame. Inspection is conducted in two ways: lot inspection and online inspection.

In a lot inspection a discrete lot is offered for inspection. A random sample is selected from the lot, with the size of the sample dependent on the size of the lot, and the fruit in the sample is graded. The whole lot is graded based upon the sample unless the inspector can clearly determine that the lot can be further broken down into smaller lots by some distinguishing characteristic. If a subplot can be identified it may be graded separately if required. The lot must be made available to the inspector so that all cartons are available for sampling and the inspector may request that the handler move cartons so that the selected cartons can be inspected. All overwraps, ties, tapes, etc., should be removed to facilitate inspection. Lots will not be retied, retaped, etc., by the inspection service. The inspector will not inspect fruit in a dangerous or hazardous location. The handler shall not interfere with the inspection. The inspector stamps or supervises the stamping of all cartons passing the inspection.

Online inspection is conducted in the packing plant. The inspector takes samples at randomly selected time intervals. The fruit so inspected is considered to be representative of the subgroup immediately preceding the inspected fruit. If the sample fails the subgroup is rejected and must be reworked. Stamping of cartons is usually done automatically on line. The inspector must be on the premises at all times when the inspection stamp is not secured.

Some of the packing plants have lot inspections on local or Canadian shipments. Although lot inspections might be cheaper on a time basis, inspections of U.S. mainland- or Japan-bound fruit on a lot basis may not be feasible since

a rejection would mean that all boxes must be opened, reworked, and resealed. It should also be remembered that lot inspection of sealed cartons outside of the packing house will require that those cartons opened for inspection cannot be exported since the quarantine was broken.

As a service to the handlers, the inspection service submits copies of the certificates to the PAC to meet the requirements of the marketing order.

The handler may request an appeal inspection if he disagrees with the results of the inspection. The reinspection will be conducted by another inspector. The handler will be charged for the second inspection if the results are substantially the same as the first inspection; no charge will be made for the second inspection if the results of the first inspection are overturned.

The inspection service requires payment of charges in thirty days from the billing date. Failure to remain current will result in the establishment of a payment schedule and cash payment for any further inspections. Failure to meet the established payment schedule will result in refusal to conduct inspection.

The marketing order allows a handler to handle uninspected fruit if they request inspection for a lot, within normal working hours, and the inspection service advises the handler that it is not practicable to provide inspection at the time and place designated by the handler. The inspection service gives the handler a waiver number for the lot of fruit for which the inspection was requested. The handler shall conspicuously mark one end of each container with the waiver number given by the inspection service in letters at least ½ inch high. Each lot requires a separate request and separate waiver number. Although uninspected, the fruit must meet the marketing order grade and size requirements.

The Department of Agriculture will also provide dumping certificates, on a fee-for-service basis, as evidence that fruit delivered to a handler for sale for the account of a grower (in other words, consignment sales) was not sold and thus not subject to assessment. The department also enforces minimum export requirements for papayas, which currently is Hawaii No. 1. The department will assist the grower in recovering delinquent payment from a dealer. These services are state requirements and outside of the Papaya Marketing Order.

The PAC is charged with establishing rules and regulations to assure compliance with grade,

size, pack, and container requirements and to identify inspected containers of papayas. The inspection service stamps all containers that pass inspection as an aid for the PAC in identifying the lot. The inspection service does not conduct compliance work for the PAC, it does not inspect fruit for which no request for inspection is received, nor does it actively seek out handlers who are not having their fruit inspected. The inspection service does report any uninspected fruit or other suspected violations of the marketing order if it observes these violations during its normal course of business so that the PAC can take compliance action against the handler.

The following are some suggestions on how to cut inspection costs: Grade your fruit correctly. Don't push the tolerances. Handle, store, and treat fruit properly prior to inspection. Reduce the use of overtime and night differential. Make lots accessible; remove tape, string, etc., before inspection. Locate inspections so that travel time is reduced. Have fruit ready for inspection at the time agreed upon. Request lot inspections when feasible. Assist the inspector in supervised stamping. Improve the efficiency of the packing line.

I hope that this gives you a better idea of why the department is involved in the Papaya Marketing Order and why we do what we do.

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 Theresa Takiue, Hawaii Dept. of Agriculture  
 Bobby Tamaki, Diamond Head Papaya Co., Ltd.  
 Paul Texeira, Hawaii Dept. of Agriculture  
 Betty Jo Thompson, CES - Hawaii County  
 Frodel Tolentino, Grower, Ono PAC  
 Tadashi Tojo, CTAHR  
 Roy Tokuyama, Diamond Head Papaya Co., Ltd.  
 Tsuyoshi Tsumura, Diamond Head Papaya Co., Ltd.  
 David Tuttle, Air Canada/Japan Air System



Lyle Wong, Hawaii Dept. of Agriculture  
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Edison Yadao, Puna Management Corp.  
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